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PRICES AND PROFITS.

IT is not too much to say that prices in electric lighting have been cut down to a figure which will barely allow on the prime cost the profit the engineer expects on ordinary work. By ordinary work, we mean that on which there is no extraordinary charge in the shape of royalty, but simply charges due to expenses of management and to other items common to all engineering works. This fact proclaims to the shareholders in many electric lighting companies a very sad outlook; for if it means anything clearly it is this, that most of the money paid for patents must be written off the capital account before a satisfactory divdend can be paid. In other words, shareholders must be content to sacrifice the cash they have paid for their patents and in the future refrain from including in their balance-sheet their patent rights as valuable assets. There is no escape. With a royalty charge on their manufactures they cannot compete with the private firms who have no royalty to pay; and since the return for capital expended in patents was anticipated from royalties, any prospect of return for the huge sums expended at the time of the companies' formation is absolutely hopeless.

We do not say that all existing patents are worthless, but we do say that the great majority are. The wholesale depreciation induced by the expiration of the Gramme patent in this country reduced the value of most dynamo patents to nothing, and on every side there sprung into existence firms making Gramme machines without let or hindrance—firms unhampered by large sums paid for patents, who could work for a fair profit on prime cost and at the same time secure an ample return for their capital. Before these firms the fancy prices of the companies could not stand. Down they went with a rush, and soon it was discovered that if the companies were to compete with their younger rivals their royalties must be sacrificed and their prices fixed on a basis similar to those of their competitors. Now and again we find directors deceiving themselves with the idea that they have in their patent rights assets of value. But their valuation is easily arrived at. Let them take the lists of other makers in their hands and compare prices. If they can command for their machines in the open market a higher price in consideration of the superiority which their particular patents give them, well and good, they have some value. If not, they are worthless; and we think on fair examination it will turn out mostly this way.

But turning from dynamos to arc lamps, where is the value of patent rights? The name of arc lamp patents is legion, and lamps are as the sands of the sea shore in multitude. Notwithstanding companies exist which have paid thousands of pounds for their patent rights, arc lamps which will work satisfactorily may be made by anyone. It was a splendid stroke when the Pilsen Company decided to grant to other makers the right to make their lamps on royalty. But the Company shortly found that the royalty was too high, and they halved it. Nevertheless their business does not increase. And why? Because the best lamp in existence will only stand a royalty charge of nominal figure. Once more, let the shareholders who have paid large sums for arc lamp patents compare prices.

But though large amounts have been expended in buying patent rights now worthless, there are rights which up to the present have withstood every assault. Amongst these are the patents for high resistance incandescence lamps. We have discussed the recent trial respecting these, and another trial will come on shortly. Here we merely call attention to the fact that the rights of the proprietory company have withstood one trial and may withstand another. Assuming that they do, we greatly doubt if in the purchase of unassailable rights to manufacture incandescence lamps, the shareholders have received full value for their money. A case involving the right to employ induction transformers for the distribution of electricity will be heard shortly, when the law courts will indirectly decide whether the company who hold Gaulard and Gibbs's patents have or have not an asset of value. At present half-a-dozen companies and firms are manufacturing transformers, and a decision favourable to Gaulard and Gibbs will doubtless mean damages proportionate to the work these manufacturers have carried out. Of the merits of the case we say at present nothing, nor do we enquire on which side right is.

Coming to storage cells, there are held by the Electrical Power Storage Company patents of undoubted value and rights which, up to the present, have been recognised by all those engaged in extensive manufacture. Though the patent rights are worth a deal of money, it remains an open question whether the royalty which can be charged without detriment to business will give the shareholders a return commensurate with the capital expended in buying them. This question time only can answer.

We in England are constantly and naturally crying out against monopoly, but there are some monopolies to which the holders have inalienable right. It is well to remember that every patented invention is a monopoly for the inventor or the buyer of the patent rights. As long as the invention can be monopolised it is of value as a royalty-producing asset. When the monopoly has ceased, or when the patents of other inventions equally good have fallen out, it ceases to have the value which letters patent confer. When the monopoly of invention refers to a small matter it does not then attract attention; when it is a huge affair, pressing hard upon us, we are naturally desirous to see it overthrown. But the principle upon which letters patent are granted is monopoly of the invention for a fixed period, and strict equity declares that an inventor has the right to

monopoly whether his invention is important or unimportant, provided he shows that his claim to a patent is a just one. Above all things let us be honest. It is only when the merit of an invention is acknowledged that the agitation against monopoly begins. When it is found that the invention is of real value, when knowing its value men would do anything to possess the benefits it confers on them, when fruitless attempts have been made to produce equally good results while evading the patents, and when the patentee's rights have been questioned on every hand—then we say is the time to hear the no-monopoly hounds hunting the inventor in full cry.

But speaking of electric light work generally, prices during the last few years have been terribly forced down, and commercial throat-cutting has been the rule. There is constant temptation for manufacturers to take work at bare cost, or at such prices as will cover expenses without leaving anything for profit. If they succumb we cannot blame them. As regards machines, a dynamo weighing half a ton will probably cost as much to make as it did four years ago, but it gives twice the output, and manufacturers have to sell in consequence machines to twice the lamp capacity before the same profit is made. Many new firms have started during the last two years, and the competition has raged more and more fiercely. See, then, how greatly the demand must increase in order that the workshops may be full, and that fair profits on capital may be made.

But does the contractor get better prices? Not at all. In many cases he has cut the price down to an extent such that he must palm off inferior goods on his customer to make a bare living. In time Nemesis will doubtless overtake him, but at present he gets enough to eke out a precarious existence on his ill-gotten gains. In many instances first class contractors cannot get the work at paying prices, and so it goes past them. They have but to wait. If they can go on till the dishonest are weeded out an abundant harvest awaits them, if not—well it is Fate, they are the weak and must perish. We cannot save them.

WE understand that an alternating current machine is being constructed by a well-known company, which it is expected will be set to work in a central station very soon. In this machine the armature remains fixed, and the magnets, or, more correctly, magnet rotates. The latter, we believe, consists of a solid cylinder of iron on which the magnetising coil is wound, and from which projects radially on each side a number of bars which resemble wheel spokes projecting from a central hub. All the spokes on one side are of N. polarity, all those on the other of S., and the armature coils lying in a circle between the ends of each two opposite spokes constituting a pair have, as the spokes rotate, currents induced in them.

A WELL-KNOWN firm is at work on a new alternating current machine where the magnets are fixed and the armature rotates. In this machine the magnets are arranged in circles, one on each side of the armature; but this arrangement differs from that of other machines, in that while half the magnets on one side are N. and half S., they do not follow alternately, but come all the N. poles together and all the S. poles together. The facing poles of magnets on the two sides of the armature are, of course, of opposite sign. We shall await with interest the results obtained from these two machines.

MR. EDISON'S name is being employed in America to advertise a remedy for neuralgia. It is said that the distinguished inventor was a great sufferer from that nervous disorder, and the skill of all the physicians failed to give him relief. As no other could cure him, he determined to cure himself. Researches and experiments resulted in the production of "Polyform," which had, according to the advertisement, a completely satisfactory result. A certificate bearing Edison's signature attesting that the preparation known as "Edison's Polyform," is made according to the formula devised and used by himself, is given away with each bottle. This savours somewhat of quackery, and we are prompted to ask why Mr. Edison did not test the virtues of the electric current for the relief of his neuralgia. We are assured that it is of certain efficacy for the purpose.

IT falls to the lot of all editors to receive gratuitous advice as to the proper conduct of their journals, and we are not exempt from the general experience. A Yorkshire solicitor, who subscribes to the ELECTRICAL REVIEW (and seems to doubt the wisdom of longer doing so) for the benefit of one of his sons, feels "surprised and disappointed" that we "have taken no cognisance of Mr. Edison's remarkable invention, the phonograph," and informs us that "Mr. Edison's movements are most interesting to students and the public generally," concluding with the query whether we are unfriendly towards Mr. Edison! We are really very sorry that our views of what is required by our readers differs from the views which our legal subscriber entertains, and would assure him that we are unfriendly to none but those to whom all honest men should be unfriendly, to the man who seeks to exact a monstrous price for that which either is not his own or is of little value, to the charlatan, the fraudulent, the sham, the humbug generally. Mr. Edison has done work far too good ever to be classed amongst the shams, and, believing that his achievements are of interest to "students and the public generally," as well as to our own particular band of readers who are not *merely* students, we years ago gave a description of his phonograph, though that instrument is not an electrical one. It was invented in 1877; and after neglecting it for ten years Mr. Edison has latterly turned his attention to it, as we intimated a few weeks ago. We now learn from America that with very slight alteration indeed he has made it a working instrument which has the possibility of a great commercial future. We are glad to receive the information: and that's all. It concerns us no further—except, perhaps, to mention that instead of turning his instrument by hand as he formerly did, Mr. Edison now proposes to employ an electric motor to actuate it. We trust this information will justify us in the eyes of our subscriber, and that he will not carry out his threat of subscribing to another periodical. We might never survive such a calamity.

ELECTROLYSIS OF COBALT SALTS.

By ALEXANDER WATT.

(*Continued from page* 505.)

Potassio-tartrate of Cobalt.—A solution of this salt was prepared by digesting recently precipitated and moist carbonate of cobalt in a hot solution of cream of tartar, half-an-ounce of the salt being dissolved in about five ounces of water; the carbonate of cobalt was added in small quantities at a time until an excess remained undissolved in the vessel. The solution, which was of a deep lake colour, was then made up to half-a-pint by addition of cold water; it was then set aside to cool and settle, when the clear liquid was decanted for use. With the current from two small Daniell cells in series, a bright coating of cobalt was obtained upon a sheet brass cathode immediately after immersion, but the colour was not so purely white as that obtained from the citrate and some other cobalt salts. On removing the plate from the bath, it was noticed that while the deposit on the surface facing the anode was streaky, and otherwise ununiform in character, the *back* of the plate had received a perfectly uniform coating of cobalt. Thinking that possibly the plate might have been inadvertently reversed when removing it from the bath, a fresh plate was placed in the liquid, and shortly after examined, with the same result, namely, a streaky and partial film on the surface of the plate facing the anode and a perfect film on the opposite side. The experiment was repeated two days after, when precisely the same phenomenon was noticed—the back of the cathode being perfectly coated, while the surface nearest the anode received only a slight trace of the metal in parts. As I do not remember having met with such an electrolytic freak before, I purpose renewing the experiment with a newly prepared solution of the same salt.

Chloride of Cobalt.—A bath was prepared by dissolving 150 grains of crystals of this salt in half-a-pint of water. With the current from two small Daniells, a very quick and bright deposit was obtained upon a brass plate, the metal being coated almost immediately after immersion. After a short time the deposit assumed a dull appearance. The solution is a very good conductor and works well with an anode surface about one-third less than that of the cathode.

Chlorides of Cobalt and Ammonium.—A solution of the cobalt salt was first prepared by dissolving 150 grains of the crystals in half-a-pint of cold water. To this solution was added 100 grains of powdered salammoniac, and the liquid was well stirred until the salt was dissolved. With the current from three small Daniells, a very quick deposit of good colour, and very bright, was obtained. After about ten minutes' immersion, the plate was covered with a blistered film, the lower part being coated with small but brilliant nodules of cobalt. The anode had been freely dissolved and was bright and clean. Two cells were next tried, and a fresh plate immersed, when the deposit, as before, "struck" immediately; the film, however, soon assumed a dull appearance, except at the lower surface and edges, which were bright. The deposit was now perfectly adherent and uniformly smooth—that is, not lumpy, as in the former case. It was next determined to try a single Daniell, when even with this feeble current a brass plate became coated with a bright film almost instantaneously, and with the exception of a few small patches, which were rather dull, the surface continued bright. There was but little evolution of gas, even when the series of three cells was used. It is probable that this solution, with a current from three cells, would form a good electrolyte for producing electrotypes in cobalt.

Chlorides of Cobalt and Sodium.—This combination, which was first suggested by Becquerel, was next tried, a solution of the cobalt salt being first prepared by dissolving, as before, 150 grains of chloride of cobalt crystals in half-a-pint of water. To this solution about 100 grains of common salt were added, and the liquid stirred until the salt was dissolved. As in the last experiment, the current from a single small Daniell cell was sufficiently strong to obtain a prompt film of cobalt upon a brass plate immediately after immersion. The deposits from this solution did not exhibit the tendency to become dull in patches, noticed in the former experiment, but continued uniformly bright, and of good colour, during a long immersion of the cathode. The anode, as before, dissolved freely and remained bright and clean.

Chlorides of Cobalt and Potassium.—A solution of these salts was prepared by dissolving 150 grains of the cobalt salt in half-a-pint of cold water. 100 grains of chloride of potassium were then added, and dissolved, with stirring, as before. With the current from a single Daniell, the deposit of cobalt took place upon a brass plate almost immediately after immersion. The film obtained was bright, and of a good white colour, but became somewhat dull after a few minutes. It should be mentioned that the dull character which the film assumes in some, but not all, solutions, does not necessarily render such liquids impracticable as depositing solutions, for the process of polishing would soon remove the dull "burr," as it is called: at the same time it is not well to employ cobalt solutions which yield a dull deposit too soon after the articles to be cobalted have been put into the bath. It is never a good characteristic of any electrolyte to be employed for coating metals for art purposes that it yields a dull or matted film, unless specially required to do so, as in *dead* plating and gilding. When metallic surfaces are polished before as well as after plating, as is the case with nickeling, such surfaces will retain their brightness in most well prepared cobalt solutions, with the exception of a slight pearly, or opalescent, appearance, which is readily removed by the ordinary buffs used in polishing.

Acetates of Cobalt and Sodium.—This bath was prepared by adding about 50 grains of acetate of soda crystals to half-a-pint of the acetate of cobalt solution described in the first experiment of this series. The current from a single Daniell was first tried with the simple acetate of cobalt solution, but only a very trifling deposit took place on a clean brass plate after some seconds immersion; the acetate of soda crystals were then added and dissolved in the liquid, after which a clean brass plate was put into the bath, which soon became coated with a bright film of cobalt, of silvery whiteness, which character it sustained during a long immersion. The anode kept exceedingly bright and clean in the liquid, which latter, however, became slightly turbid after a time. The deposited metal was very adherent.

Phosphate of Cobalt.—A solution of this salt was prepared by dissolving freshly prepared carbonate of cobalt in a strong and hot solution of phosphoric acid, the resulting liquid being of a fine pink colour. With the current from a single Daniell there was evolution of hydrogen, but no deposit. With two cells, a patchy film of cobalt only could be obtained. Three cells were next tried, when a prompt coating of the metal, of good colour, was received upon a newly prepared plate. The evolution of gas was considerable. On examining the film, after half-an-hour's immersion, it was found to be very adherent, and uniform in character. It should be noted that during the electrolysis flocculent particles formed on the upper surface of the plate, which became dislodged by the hydrogen bubbles, and gradually subsided; these, however, appeared to redissolve in the liquid.

Ammonio-carbonate of Cobalt.—A solution of this salt was formed by adding moist carbonate of cobalt to a strong solution of carbonate of ammonia, in small quantities at a time, the liquid being constantly stirred after each addition of the cobalt salt; the resulting solution, which was of a pink colour, was first tried with a current from three cells, when a prompt deposit of cobalt of brilliant whiteness was obtained upon a brass plate. There was vigorous evolution of hydrogen, and after about ten minutes the deposit assumed a dull appearance all over.

Double Sulphates of Cobalt and Ammonium, with Chloride of Sodium.—Well knowing, from experience, the great advantages which are derived from the addition of common salt to nickel baths, by which not only is the conductivity of the liquid greatly increased, but the character of the deposited metal materially improved, I determined to ascertain whether similar, or other advantages, could be obtained by adding varying proportions of common salt to a solution of the double sulphates of cobalt and ammonium. With this view I prepared a solution bath, by dissolving 1¼ ounce of Wiggin & Co.'s double salts—a supply of which had been kindly forwarded to me by the firm, at my request, for experimental purposes—in hot water, after which cold water was added to make up a quart of depositing solution. When the solution had become cold a brass plate was immersed, the current from a single Daniell being employed. In about half an hour, by which time a sufficient coating of cobalt had been obtained for the purposes of comparison, the plate was marked and set aside. Thirty grains (or about 5 per cent.) of common salt were then added to the bath and dissolved, with stirring. A clean plate was then put into the liquid, and allowed to remain therein for half an hour. This addition of salt did not appear to make any apparent difference, so far as rapidity of deposit was concerned, but the film was somewhat less bright than that obtained from the double salt *per se*. Another 30 grains of chloride of sodium were now added and dissolved as before, and a second plate immersed for about the same period, when the deposition took place with promptness, and a good film was obtained at once. When the plate had been in the bath about half an hour the film assumed a pearly dulness, which, however, was readily brightened by light scouring with moist silver sand. Thirty grains more salt were then added —making 15 per cent. in all—and a fresh plate immersed for the same period as before, at the end of which time the film was still more dull in character, but exceedingly uniform, and of a good white colour. On comparing the three latter results with the first plate coated in the plain solution of the double salts, the dead whiteness of the former contrasted greatly with the comparatively bright surface of the latter. On reviewing these results, and comparing them with the effects produced by the addition of common salt to nickel sulphate solutions, I am constrained to admit that the advantages are much more marked in respect of the latter; still, I am disposed to think that the addition of a moderate percentage of salt to the double sulphate solution somewhat improves the character of the deposited metal, by rendering it, perhaps, somewhat softer. I may mention that the dull bloom, or burr, which appears on the surface of the metal deposited in the *salted* solution is so soft that it readily yields to the pressure of the finger nail; it would, therefore, become brightened by ordinary polishing without the least difficulty. In each of the foregoing experiments the surfaces of the electrodes were about equal.

Salicylate of Cobalt.—A solution of this salt was formed by dissolving moist carbonate of cobalt in a hot and strong solution of salicylic acid, when a faintly pink liquid was obtained. This solution was electrolysed with the current from two Daniells, when a bright, but very dark-coloured film was at once obtained upon a brass plate; the film continued bright during the experiment, and when the plate was removed from the bath the coating assumed much the appearance of brass which has been dipped in a weak solution of chloride of platinum and afterwards rubbed bright.

Nitrate of Cobalt.—A weak solution of this salt was electrolysed with the current from two cells. After a few seconds' immersion a brass plate received a slight film of cobalt, but on the plate being returned to the bath it soon became coated on both sides with a rich malachite green deposit of great beauty, which fell from the plate in transparent flakes, which were found to be insoluble in the solution and also in hot water.

Ammonio-nitrate of Cobalt.—A solution of this salt gave precisely similar results to the one last named, that is to say, a slight but very adherent film of cobalt was first deposited, followed by the dark green non-metallic coating, as in the former case, the latter occurring in a minute or two after immersion of the plate. In the present instance the green deposit formed a thick mass upon the plate, which came away from it in large flakes, as also did some flocculent particles of the same substance.

Sulphate of Cobalt and Chloride of Ammonium.—A solution of the sulphate was first prepared, by dissolving 150 grains of the salt in warm water, and then diluting the liquid with cold water to make up a half-pint bath. To this was next added about 50 grains of sal ammoniac and the liquid stirred until this was dissolved. With the current from a single Daniell cell there was but a slight deposit upon the cathode; two cells in series were then tried, when a clean brass plate became instantly covered with a bright film of cobalt, the anode surface being about half that of the cathode. The deposits from this solution do not appear to be quite so tenacious as those obtained from most of the other solutions we have described, and consequently it might be a little risky as a depositing solution; this, however, would depend greatly upon the metal being allowed to deposit gradually.

Pyrophosphate of Cobalt.—To form an electrolyte with this salt, a quantity of pyrophosphate of soda was first dissolved in hot water; carbonate of cobalt was then added, a little at a time, and the mixture well stirred; the liquid was next heated for a short time and then set aside to cool. The solution was afterwards filtered, when it assumed a faintly pink tint. With the current from two Daniell cells, a dark coloured film of cobalt—much resembling that obtained from the salicylate of cobalt, but still darker—was deposited on a brass plate, while considerable gas was evolved. The film was very adherent and appeared to have alloyed itself with the metal of the plate.

Sulphates of Cobalt and Potassium.—A solution of the cobalt salt was first prepared by dissolving 150 grains of the crystals in a sufficient quantity of hot water; to this solution was then added 100 grains of sulphate of potash, and the mixture well stirred until this was dissolved. Cold water was next added to make up a half-pint bath, and the solution set aside until cold. Two Daniells in series were employed, and an anode surface somewhat greater than that of the receiving plate, when the latter promptly acquired a bright film of good colour. There was some gas liberated at each electrode, which had a tendency to remain in a stationary position on the respective surfaces. After about a quarter of an hour or so, the deposit on the cathode assumed a dull appearance. This solution is not so good a conductor as the sulphate of cobalt solution *per se*, and cannot be recommended as a practical electrolyte, inasmuch as the deposit is less adherent than is usual with this metal. As proof of this, when the plate had been in the bath some 20 minutes or so, the film peeled off the plate, while in the liquid, and though this might be readily checked by employing a still weaker solution, the electrolyte cannot safely be considered a trustworthy one for any practical purpose.

Sulphates of Cobalt and Magnesium.—To half-a-pint of sulphate of cobalt solution, prepared as before, about 60 grains of sulphate of magnesia were added and dissolved in the liquor. The current from two Daniells was employed, and the surfaces of the electrodes were about equal. On immersing the brass cathode it immediately became coated with a bright and remarkably white film, which maintained its brightness for a considerable time, after which it assumed a slightly opalescent appearance, which could only be observed by looking at the plate sideways. For certain classes of brass or copper articles it is probable that this compound solution might be found useful, and if applied to polished work the ordinary operation of "dollying" would doubtless be all that would be required to give the necessary high finish to goods of that character. The liberation of gases at the electrodes in

this solution is practically *nil*, and the deposit of metal very rapid. It is possible that other proportions of the sulphate of magnesia than those I have given might be found advantageous in practice, but I am inclined to think that those which I have named will yield sufficiently good results for all practical purposes. It is probable, also, that a somewhat weaker current than that obtained from the two small Daniells in series employed in this experiment may be found advantageous, but it is not unlikely that in such a case the full whiteness of the deposit would not be obtained, for I have frequently found that a current which is a little too weak gives an inferior colour to the film.

(*To be continued.*)

THE PHONIC WHEEL.

(*Translated from the Danish.*)

IT is with great interest that I have read Lord Rayleigh's communication of "his experience with a nearly identical apparatus," with the phonic wheel. The short account of Lord Rayleigh's apparatus, which is said to have appeared in *Nature*, May 23rd, 1878, seems to show, as far as I can see at present, that two physicists had the same idea simultaneously—a phenomenon which has often occurred in the history of natural philosophy.

In my recent paper to the REVIEW I mentioned that it had been asserted from America that a comparison between the invention of the phonic wheel and that of the synchronism, would show that the latter is the greater of the two; but being myself the inventor of both, it is quite immaterial which of them the Americans consider the more important. Should I, however, pass an opinion, I should certainly not for a moment hesitate in pronouncing the phonic wheel the principal invention; partly because the principle upon which the wheel is based is absolutely novel, whereas several modes of synchronism existed before that by means of the phonic wheel, and partly because it is the great uniformity in the motion of the wheel that makes its synchronism so perfect.

The short account of Lord Rayleigh's instrument seems to show that he did not investigate the same very closely, nor that he thought of applying it for different practical purposes, but the main point, namely, the *new kind of dynamic equilibrium* and the important auxiliary means to secure it, viz., *a ring with mercury or water*, appears to be common to Lord Rayleigh and myself. I therefore maintain the same view of Lord Rayleigh's apparatus as of the phonic wheel, and it has given me great pleasure thus to have found a sympathiser in Lord Rayleigh.

It may, however, not be without interest to compare the respective dates of our first publication. Lord Rayleigh says:—"So far as I can find, I published nothing upon the subject until March 30th, 1878, when I exhibited my apparatus at a meeting of the Physical Society, and gave a detailed statement of the theory."

As to myself, my first publications were as follows:—On the 2nd July, 1877, I sent in an application for a patent with full specification to the Danish Government. On the 22nd February, 1878, Prof. Holten laid my invention before the Royal Danish Academy of Science, and on the 8th of March, 1878, my pamphlet, "Tonehjulet," was published in Copenhagen. Those who do not read Danish will in my pamphlet, "La Roue Phonique," which I published in the same year, find the identical particulars of the theory, and all my investigations, as in "Tonehjulet."

I may add, in conclusion, that I have experienced much vexation in the last few years through Mr. Delany's arrogant usurpation, and that it is with sentiments of an entirely different nature that I have read Lord Rayleigh's communication.

PAUL LA COUR.

Copenhagen, *November 20th*, 1887.

SCIENTIFIC TOYS.

THE MAGNETIC ORACLE.

THE toy shown in the subjoined figure, taken from *La Nature*, although far from new, is nevertheless an ingenious and interesting invention cleverly modernised by the constructor. This is the way to make the oracle speak; we will afterwards give the secret of its accurate answers. We write upon 12 prepared cards a series of questions relating to history, geography, science, customs, &c. One of the company takes one of these cards at random and reads one of the questions; then the card is placed under the magician's feet, in a groove made to receive it; immediately the oracle turns on its axis, and after some oscillations becomes fixed in a certain position, its magic wand pointing to one of the numbers by which it is surrounded. On referring to the corresponding number on a list we read an admirably exact and accurate answer.

We may see that by varying at will the cards of questions and answers we may obtain from the oracle an indefinite number of replies. Nothing could be simpler than the process by which this result is obtained. The base of the toy into which the cards slip bears a vertical pivot on which rests the body of the magician whose magic robe conceals a vertical U-shaped magnet, having its two poles near the base.

In each of the cards there is another magnet concealed, a straight rod, occupying a different position for each of the 12 cards. We see that in virtue of the well-known laws of the attraction of magnets for each other, each time that a card is placed with its magnet in the base the figure will turn round this axis and effect a series of oscillations round its own axis until the poles of the U-shaped magnet-holder under its robe are opposite the contrary poles of the straight rod hidden in the card. If the base has been correctly marked previously, the divining rod will indicate the corresponding number of the answer. Says our contemporary, this application of the properties of magnets is incomparably more interesting than the study of Gauss's method, and we recommend it to parents of our young readers, who will presently be of our opinion.

THE ELECTRIC CURRENT.

READERS of Prof. Ayrton's admirable book, "Practical Electricity," will, says Prof. F. C. Van Dyck, in the New York *Electrician and Electrical Engineer*, see on page 2, a statement of that author's views as to what the electric current is *not* like.

It appears to me worth while to say something on the other side of the question, pointing out a basis of analogy between the electric current and what may be called a sound current. What follows refers to a single experimental fact, viz., that the energy developed (as neat, for instance) in an electric circuit varies as the *square* of the current in that circuit. Or, it may be put in this form, viz., the energy expended in maintaining difference of potential varies as the square of the quantity of electricity transferred from higher to lower potential.

How does this fact accord with the various hypotheses as to the nature of current? In the first place the electric current cannot be regarded as analogous to a current of *water*, for the energy of a water current varies as the cube not the square of the current. This is so important in this connection that I venture to give a brief statement of the reason for the fact, by way of reminder.

To say that the energy of a water current varies as the cube of the current, because one must maintain n-square-fold head to get n-fold flow does not *explain* the matter, but really states it from another standpoint. The real explanation is to be found in the character of the flowing substance. Water is practically incompressible, that is, its volume is independent of the pressure causing flow. Hence to get n-fold current from a given orifice or tube we must force n times as many volume-units (drops) out in a given time. Therefore each volume-unit must be made to travel n times as fast as it did when unit current flowed. Consequently, each volume-unit has n-square energy, and, as there are n times as many of them traversing the orifice or tube, the energy of the n-fold current must be n-cube-fold the energy of unit current.

Now, water acts as a vehicle of energy by virtue of its *mass*.

If, then, electricity is an "incompressible fluid," how does it come to pass that the energy of the electric current varies as the *square* instead of the *cube* of the current? Is there any way to explain it on the assumption that some other property than mass is efficient in the case?

In the second place, the electric current is plainly not a flow of "energy," for it cannot be that the energy of a current of energy varies as the square of the current.

In the third and last place, let us see how far an electric current is analogous to a sound current.

The idea can be given by making some suppositions and drawing inferences from them. Suppose, first, that the human ear were sensitive to sound of a given pitch only, and that sound had become a commercial quantity, transferred by conductors. A meter could easily be constructed to measure amplitude of vibration, and so "current." If the apparatus at the transmitting end of the line were worked by a spring suitably mounted, energy would have to be used to keep the spring at the requisite "potential." On these suppositions we should have—

(1.) Current proportional to potential.

(2.) Energy required to maintain potential proportional to the square of the current.

Just as we have in the case of electricity. It is established that static electrification is closely allied to elastic stress, and why may it not be that dynamic electricity is amplitude of vibration of some medium or media? Perhaps the difficulty of making detailed descriptions of the mechanism of the operation may be insurmountable, but it can only be profitable to insist that such a fundamental fact as the relation of current to energy must be taken into account in our theorising.

People's Lectures.—The first lecture on "Electricity in the Service of Man," by Mr. William W. Lant Carpenter, B.Sc., at the Shoreditch Town Hall on Monday night, attracted an enthusiastic audience of over 1,200 people. The chair was taken by Prof. Stuart, M.P. The lecture was abundantly illustrated with experiments and the oxyhydrogen lantern.

FEARFUL DEATH OF AN ELECTRICIAN.

AMERICAN papers state that Sidney F. Shelbourne, a prominent electrician, and a member of the American Institute of Electrical Engineers, was instantly killed by the fly-wheel of an engine at the American Institute Exhibition on the evening of the 9th inst.

Mr. Shelbourne, who was 51 years of age, was lame, one leg being considerably shorter than the other, and he was compelled to wear an iron shoe several inches in height under his right boot. Mr. Charles Cuttriss was to read a paper on "Ocean Telegraphy" at the Institute, and some 200 gentlemen interested in the subject, including the American Institute of Electrical Engineers and the Electrical Section of the American Institute, were assembling to listen to the paper.

Shortly after 7 o'clock, soon after the doors were opened, Mr. Shelbourne made a tour of inspection among the electrical exhibits. Going inside the enclosure allotted to the Tucker Electrical Manufacturing Company, Mr. Shelbourne was shown around by Robert Ashton, the engineer of the Ball Engine Company. The latter supplies the motive power for the arc-light system, while in the same enclosure or space is an exhibit of the Trenton Engine Company, supplying the power for the incandescent lights. The fly-wheel of the latter engine is 80 inches in diameter, and is separated by a space of about 3 feet from the Ball engine.

The machinery was all in motion and the Trenton engine flywheel, which sinks about 2 feet below the floor, was making about 200 revolutions a minute, when Mr. Shelbourne, who was a very large man, essayed to pass in the space between it and a stanchion adjoining the Ball engine, but his foot slipped or he was sucked in by the current of air, and before the engineer could seize him, or before he could realise what had happened, Mr. Shelbourne had disappeared within the compass of the wheel and was almost as quickly thrown out again, high against an asbestos-covered pipe supplying steam to the Ball engine.

The whole thing was done in a twinkling, but in that instant every stitch of clothing had been torn off the unfortunate man, and he lay a bleeding and shapeless mass upon the floor at the base of the engine. Not a sound was uttered except by Engineer Ashton, who almost swooned at the sudden and horrible sight. The clothing was torn into shreds, which were scattered in all directions.

But few visitors were in the place at the time, and consequently not half-a-dozen people outside of the *employés* in the immediate vicinity knew aught about the ghastly affair, and no excitement or panic resulted, as might have been the case had it been an hour later.

After all the visitors had left the building a brother of the deceased called to claim the body. He said Mr. Shelbourne was a lawyer having an office at No. 11, Gold Street, New York. He was also connected with one of the subway companies, besides being a member of the Board of Council of the Institute of Electrical Engineers.

THE THOMSON-HOUSTON SYSTEM OF ELECTRIC LIGHTING.

WE have lately had an opportunity of learning some interesting details as to the progressive nature of the Thomson-Houston system, or, rather, systems of electric lighting.

Starting originally with the now world-renowned arc lighting system, whereby 10 or any less number of arc lamps of 2,000 candle-power could be maintained in series by one machine, which by the automatic regulator enables one or the full load to be run without attention to the dynamo, the success of the company was phenomenal. In October, 1885, having been at work about three years, there were ninety-four local companies established operating this system in different cities of the Union, the total number of lights being

11,117, all of 2,000 C.P., and taking a little under one horse-power (indicated) per lamp. About that date many improvements were introduced after many months of most severe testing in the factory. The principal improvement was the small arc light apparatus, to furnish lamps giving 1,200 candles with the expenditure of half a horse-power, the current strength being 6·8 ampères.

This lamp was taken up most warmly, and it was found that for commercial and many other purposes it was as good as the standard 10-ampère system; and the local companies could rent out these lamps at a cheaper price and yet make a greater profit.

The incandescent distributor was also introduced, whereby nine or five incandescent 16-C.P. lamps could be run on the 10 or 6·8 ampère circuits respectively, and this without the slightest difficulty or danger, each lamp being quite independent of any other, and the breaking or switching out of a lamp having no effect on the others, the distributor box automatically taking care of the circuit. Individual distributors are also used, obviating the necessity of bringing all the wires back to one distributor box.

Since then Prof. Thomson has introduced his series incandescent system, enabling lamps of from 16 to 200 candles to be run in single series on the arc light circuits, the great feature being the film cut-out in the lamp and lamp-holder, which effectually prevents any chance of an open circuit should the lamp filament break. Within the last two years great attention has been devoted by the Thomson-Houston Company to incandescent lighting, and its automatic self-regulating incandescent dynamo now stands as high in general estimation as its arc machine. In addition to incandescent lamps, the company makes a great feature of these machines as the generators for the electrical transmission of power. In many of its central stations the steam plant supplying motive power to various customers, from half a horse-power up to 25 H.P., is as hard worked by day as it is at night in running the arc and incandescent lamps.

The latest development of the system is, however, the alternating induction system of distribution. The general principle is the same as the Gaulard and Gibbs, but the numerous small improvements of construction and ease of manipulation, for which American genius is so celebrated, have made this system most perfect. The Thomson-Houston Company has, we notice, recently combined with the Westinghouse Company on a question of patents, and we prophesy an immense business as the result. Up to now about 200,000 incandescent lamps have been put up from central stations on the alternating system, and the orders on hand are enormous.

The Thomson-Houston, then, appears to hold a unique position. It has special plant and apparatus for every practical system of distribution. Arc lamps in series, up to 50 on one machine; incandescent lamps either in multiple or single series, low tension, self-regulating incandescent machines, motors of all descriptions and all horse-power, and lastly the alternating induction system. The result is, that at the present moment the company is overwhelmed with orders, and is doubling its factory for the third time in three years. It has now over 280 local companies working on one or more of its systems, with a total of over 30,000 arc lights and over 200,000 incandescent lamps. Every one of these local concerns is prosperous.

These figures apply only to central station plants. About half as many more are working in isolated installations in mills, &c., making a grand total of over 45,000 arc lamps in use at this moment.

Electric Lighting in Holland.—New works for the manufacture of incandescent lamps have been established at Middleburg, in the province of Zeeland, the two existing Dutch establishments having been unable to meet the demand, owing to the rapid adoption of the electric light in Holland.

THE ELECTRICAL CONDITION OF THE PEAK OF TENERIFFE.

THE Hon. Ralph Abercromby, writing to *Nature*, says:—The limited number of observations on atmospheric electricity which have been already made all point, with one exception, to a normal positive difference of potential between a point some few feet above the earth and the ground itself. The only notable exception to this law was found in some observations which were made on the Peak of Teneriffe about thirty years ago. Then it appeared that the condition of the Peak was constantly resinous or negative. These observations were, however, taken with a gold-leaf electrometer, and some doubt has been expressed as to whether the sign of the electricity was correctly obtained.

I therefore thought, when taking a short trip to Teneriffe, that it would be useful to examine this question by means of the improved electrical instruments now available.

Through the courtesy of the Meteorological Office I obtained the loan of a Thomson's portable electrometer, and, through the kindness of Mr. Whipple, received at Kew all necessary instruction in the use of the instrument, and special caution as to the possible difficulty of getting a good "earth" on sun-burnt lava. Any success the observations may have had is entirely due to his care and forethought.

I was only able to stay about a fortnight on the island, but the results obtained were so uniform that there can be no doubt as to their accuracy.

The height of the electrometer fuse was always about 5 feet 6 inches above the ground. At the Port of Orotava, at the base of the Peak, and about 50 feet above sea-level, the mean of eight sets of observations—each set usually consisting of six determinations—gave a potential of 138 volts. The highest was 193, and the lowest 98 volts. These, and all I obtained in Teneriffe, were uniformly positive.

One day I took a skirmishing expedition to the rock of Gayga, a portion of the rim of the old crater, 7,100 feet above the sea. On the way up, while on the pretty uniform slope of the mountain, at 3,800 feet, the potential was only + 99 volts, while on the rock itself, tension rose to 257 volts. The rock is a long sharp, narrow edge, perhaps half a mile long, with a precipitous cliff of 500 feet on one side. The rock was composed of dry lava, and I thought a little damp, but still the earth observations were not quite so accordant as usual.

A few days later, therefore, when starting for the top of the Peak, I took, as suggested by Mr. Whipple, an ordinary 66-foot iron surveyor's chain to be laid along the ground and connected with the instrument. The readings at different heights, on the way up, were as follows:—

At 5,600 feet, on the slope of the mountain, 111 volts.

On the Canadas, a rough flatish ground that forms the bottom of the old crater, at 5,800 feet, 139 volts. The ground here was pumice and pumice dust, so I tried running out the chain to see if the earth-readings would be altered. There was not, however, the slightest change, and to show the character of the observations, five out of the six earth-readings gave the same number.

At the *Estancia de los Ingleses*, 10,500 feet, situated on the slope of the main peak, the potential fell to 118 volts. The sun was setting, and dew falling so fast that the top of the electrometer box was covered with wet. There could be no doubt then of obtaining a good earth.

On the top of the Peak, 12,200 feet, the potential actually rose to no less than 549 volts. This was at 8 o'clock in the morning of October 24th. The wind was blowing at the rate of about 10 miles an hour from the north-east, while the dry and wet bulb thermometers marked 31° and 26° respectively. There was a little white frost on the ground, and the earth-readings, without the chain, were remarkably uniform, only differing by the 11-100th of a turn of the screw.

The results of all the observations points unmis-

takably to the conclusion that during this month of October *the electrical conditions of the Peak of Teneriffe were the same as in every other part of the world. The potential was moderately positive at the same distance from the ground even at considerable altitudes, but the tension rose enormously round a sharp point, and a projecting edge of rock.*

It is well known that there are very few thunderstorms in Teneriffe, though one passed near us at Orotava without affecting the indications of the electrometer. Would it not be interesting to measure the potential on the summit of a mountain like Kina Balu in Borneo, which is about the same height as the Peak of Teneriffe, but situated in the heart of the equatorial zone of the constant electrical discharge?

We had one day of very heavy rain, when possibly some negative indications might have been obtained; but I did not think it expedient to let the instrument get drenched.

But besides obtaining these decisive electrical results, I was also very fortunate in some other observations during the short stay in Teneriffe.

We saw from the *Estancia* the shadow of the Peak at sunset gradually creep along the land and surrounding sea, and then stand up in the air like another peak rising above the horizon. This is what is so often seen from Adam's Peak in Ceylon, and from Pike's Peak in Colorado.

Then our observations confirmed not only the important discovery made by P. Smyth, that cloud is not formed at the junction of a south-west current flowing over a north-east trade, but the even more important fact that there is no such thing as the supposed simple return current from the equator. At Teneriffe, as in every other part of the world I have ever visited, the general circulation of the air is on a complicated screw system, the practical effect of which is that as you ascend, the wind always comes more and more from your left hand as you stand with your back to the wind. You do not come abruptly to a south-west wind over a north-east trade, but pass successively as you rise from the surface from north-east through south to south-west, and then probably to west, or even north-west.

I also made some very important observations on the local formation of halo-forming sky, and got an excellent photograph of the genesis of a cirrus cloud from a moist current rising over the Peak, but space will not allow me to explain the results in this place.

CUTTRISS'S IMPROVED SIPHON RECORDER FOR OCEAN CABLES.

ONE of the most interesting exhibits at the American Institute Electrical Exhibition is that of the Commercial Cable Company, which has in operation one of the new cable recorders designed by Mr. Charles Cuttriss, the electrician of the company. Visitors constantly surround the apparatus, and many obtain for the first time a knowledge of how a cable message is received.

The great improvement of this instrument over the older forms consists in the adaptation of magnetism in place of static electricity as a means of maintaining the vertical vibration of the siphon. This vibration is necessary in order that there may be be no friction between the marking point of the siphon and the paper slip on which the signals are recorded. The instrument is also more easily adjusted than the older forms, all the adjustments being clearly in view of the operator, so that any desired change can be made in the signals without interruption to traffic. The arrangement is such, that, if necessary, the signal coil can be moved and replaced in a few seconds, without changing or loosening the fibres or disturbing any other part of the instrument; or the magnets can be removed and replaced without disturbance to the signal coil or its attachments.

The paper slip on which the record is written is drawn at a regular speed under the point of the siphon by a small electric motor placed to the left of the recorder at a distance of about two feet from the siphon. By this arrangement the operator does not touch the slip, but reads and transcribes the signals as they pass under his eye, and he is generally writing the same word that the sender at the distant station is transmitting, instead of being three or four words behind, as is the case with the older forms of recorders, owing to the paper being hidden for some length behind wheelwork. This alone effects a great saving of time in the reception of short messages.

The motor has been specially designed to run with six or eight gravity cells, as it has been found that not only are they cheaper to maintain, but they require much less attention than any other kind and are more easily duplicated.

Our engraving, an electro of which, together with a description of the apparatus as it appeared in the *Electrical World*, has been sent to us by a New York friend, and shows clearly the functions of the different parts of the apparatus, of which we will first refer to that part of the instrument appertaining to the vibration of the siphon, and which insures a perfect record regardless of the state of the weather or the humidity of the atmosphere.

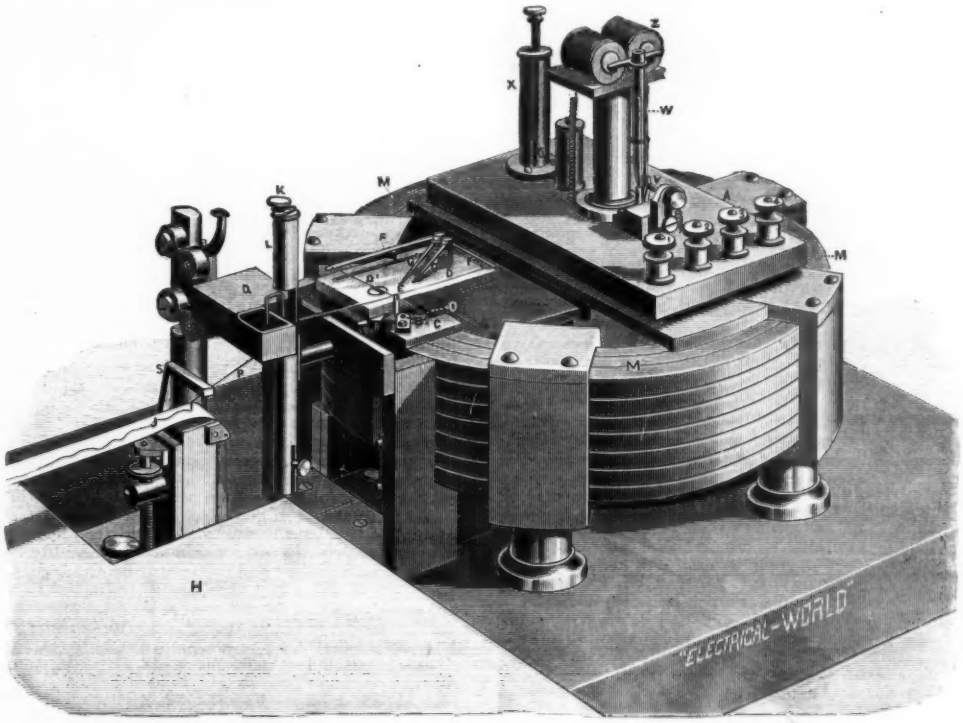
The siphon, P, is a fine glass tube about one-hundreth of an inch in diameter, one end of which writes upon the paper slip, J, and has attached to its point a piece of No. 30 iron wire about one-eighth of an inch long, which serves as an armature and is controlled by the impulses of the magnetic table, T, over which the paper slip passes. The impulses of the magnetic table are controlled by the vibrator, which is placed on the large permanent magnets, M, M, and consists of a glass tube, W, which is connected by a tube of India-rubber to the mercury reservoir, X. The glass tube is supported by a steel rod carrying a spring contact point, V, and carries an armature, seen opposite the poles of the small electro-magnet, Z. When a battery of three or four gravity cells is connected to the terminals 1 and 4, the glass tube commences to vibrate at a rate determined by the height of the column of mercury in the glass tube, W, the height of which can be regulated by turning the milled thumbscrew at the top of the mercury reservoir which connects with a plunger within the latter.

From the terminals 2 and 3 two wires connect to the electro-magnet of the magnetic table, T. Thus every time the contacts at V are closed the table is energised and the siphon is drawn down to the face of the paper by the attraction of the magnetic table for the small piece of iron which is attached to the point of the siphon. If the impulses given to the siphon are in accordance with its natural rate of vibration a succession of fine dots of ink will be left on the paper in a perfectly straight line so long as the siphon is not moved laterally by the coil, R, and a supply of ink is maintained in the ink pot, Q. Should the impulses given to the siphon by the vibrator not be in accordance with the natural rate of vibration of the siphon, it will not vibrate and the record will fail. But by manipulating the plunger in the tube, X, the height of the column of mercury, W, is varied, so that the rate of the impulses can be maintained anywhere between 60 and 100 per second. Hence any siphon that would be suitable for the instrument can be controlled, as its rate will lie within these limits. When the proper height of the mercury has been once determined, which is generally found in less than half a minute, the siphon will continue to vibrate until it is broken or removed for other causes.

The signal coil, R, which is moved by the currents transmitted from the distant station, is pivoted at the bottom and top, B, in agate bearings, and is free to move in the annular space between the poles of the permanent magnet, M. On the top of the coil there is attached an aluminum extension, E, which has a narrow slot at its upper end through which passes the regulating fibre, D', one end of which is attached to a rigid support, O, the other end being fastened to a flexible spring, F. The strain on this spring and this fibre is regulated by moving the index, G', and the strain thus

produced controls the movements of the signal coil, R. Close to the point, E, and at right angle to the fibre, L', there is another fibre, D, one end of which is attached to an exceedingly delicate spring, F, the other end being fastened to an extension from a fine brass wire contained in the tube, L, to which the siphon is secured. The upper end of this strained wire is attached to the thumbscrew, K, so that by turning the latter the siphon can be moved laterally over the face of the paper to any required position.

Thus it will be seen that if the siphon is moved off the paper slip toward the front of the instrument when the fibre, D, is strained by moving the spring, F, outwardly, the siphon can be pulled by it into a position over the centre of the paper; the torsion on the strained wire and the strain on the spring now balance each other, and if the two cross fibres are fastened together at a point as near as possible to the extension, E, any movement of the coil will be multiplied and transmitted by means of the fibre, D, to the siphon. By lifting the fibres out of the slot, E, and turning the coil toward the front of the instrument, the coil and



part of the pole piece, C, can be removed from the instrument without disturbing any other part, and when replaced, no re-adjustment will be necessary.

This instrument has been worked over one of the Commercial Cable Company's cables at a rate of over 30 words per minute, each signal at that rate being perfectly clear and distinct.

The exhibit of the Commercial Cable Company also includes samples of its cables, deep-sea, shore end, &c., and adjoining these are specimens of sections of cables damaged by ice in Nova Scotia. Several of these, among them a heavily-armoured shore end, are crushed out of all resemblance to a cable, and explain graphically why interruption to cable traffic occurs occasionally.

The whole of the front of the instrument is protected by glass plates, which have been removed to add to the clearness of the illustration.

Welcome Gifts.—The Sawyer-Man, the Edison, the Brush-Swan, and the United States Companies have each promised an electric light plant for the new Electric Club House in New York.

THE PHILADELPHIA STREET RAILWAY CONVENTION.

(*Continued from page* 511.)

During the meeting, Mr. F. J. SPRAGUE gave the following address:—

THE APPLICATION OF ELECTRICITY TO STREET RAILWAYS.

To be asked to say something to the members here comes to me rather in the form of a surprise, as I had come here only for a few hours to hear the practical suggestions and criticisms by the men who are operating the street railways of the country, and not to attempt to instruct them. On account of the limited time at my disposal, I can only briefly refer to the application of electricity to street railways.

As most of you are aware, there are three different systems by which it is possible to apply electricity to street railways: Overhead conductors, underground conduits, and storage batteries. The overhead system in point of cost is the cheapest, and it is the only one up to the present which has been developed, and is in most frequent operation. The conduit system is receiving the attention of a large number of workers in this field, and unquestionably will be used in some cases where a large number of cars are in operation and where the return will be in proportion to the investment. The storage battery system is likewise in an experimental stage in Philadelphia, Baltimore, Boston, St. Louis, and New York. We shall soon have cars of different kinds and equipped with different makes of storage batteries in operation, some of them under our own and others under local control, and in this way we shall be able to get hold of the practical views which on consideration may be of value to you. In point of cost the overhead line is of course the cheapest, and either this or the storage battery system will be the one to be used where there are only a few cars and where running under long headways.

The conduit system is of course to a certain extent preferable to the overhead line, as overhead wires of every kind, for whatever use, are objectionable, and possibly of a tentative character in view of the ultimate development of the storage batteries. The conduit system, as I have said, is in a somewhat experimental stage. It is impossible to put in such a system except by liberal investment of money, because it must stand the same strains and conditions of weather and traffic which a cable conduit must stand, and in addition must afford ample protection for the conductors on which the operation of the whole system depends. Such an investment of course cannot be made where cars are run at long intervals, because the traffic receipts would not afford a dividend sufficiently attractive on the investment. The storage battery offers the advantage over all others of perfect independence of action; but it has the disadvantages that the capacity of the storage battery is limited, the weight of the battery is large and the life and duration of it is somewhat uncertain. Storage battery companies are in the habit of guaranteeing their batteries for two

years' operation, provided no unreasonable strain on their capacity is made. The system will soon be presented for your consideration.

The question of traction, which has been objected to by some street railway men, seems to have been met. We have had a car take a 6 per cent. grade, driven with only one pair of wheels. This may have been exceptional, and have been done under favourable circumstances, but it *was* done and over sharp curves, and if both axles are independently driven, not the one made dependent upon the other, there is no question about its being done under all circumstances. In the adoption of any system or any method of operating cars by electricity, the question of the number of cars to be operated is a most serious one. If operating one or two cars over 5 or 6 miles, electricity had better be let alone, and even when operating two or three cars the question of headway is important unless the power is derived from some existing station or under exceedingly economical conditions. There is a point in any system, whether overhead, conduit, or storage batteries, in which a certain number of cars under certain conditions of station operation must be operated before the economy will exceed that of horse traffic; the greater the number of cars the greater economy.

The conduit has not only to withstand the strains and changes of the surface, but it has got to afford ample protection to the electrical conductors. The placing of wires underground for lighting, telegraph, &c., has been very successfully done in several cities, but, even with the advantages of a supposed-to-be-well-protected conductor, many difficulties have arisen. When such a conductor, however, has its protection removed and is carried in an open conduit entirely exposed, without a good condition of drainage, such as appears in Boston, where oftentimes in spring the water will collect in pools six or eight inches deep, it is useless to construct poorly or cheaply. You have got to put the money into the ground if you are going to have a system economical and free from accidents.

You ask: Would you use electricity on a line running six cars? If I were you and I believed in electricity I would certainly use it, as it would be more economical in that case than horses.

Mr. CLEMINSHAW asked what would be the cost of a 5 or 10 horse-power motor.

Mr. SPRAGUE: I am not here to say what the price of motors is. But in plants of that kind there are four elements of cost: there is the steam plant, the dynamos, the apparatus which carries the electricity to the motors, whether it be overhead line, conduit system or storage battery, and finally, the cost of the motors themselves.

As regards the probability of this application of electricity, I may instance the fact that we have now under way a contract at Richmond on which 11 miles of track are being equipped with 40 cars to be operated with overhead line. The grades run as high as 8 per cent., although ordinarily I do not favour going above 6 per cent. where I depend upon the rails for adhesion. This plant is to be operated from a power station which has been specially put in for it.

In the matter of handling excessive grades, it seems to me inadvisable to subordinate an entire system to a capacity which is necessary to climb some one grade which will occur. It would seem as if it would be advisable to use an independent motor or cable at the point where the grade occurs. For instance, if the ordinary grades on a line run 2 or 3 per cent., and there should be for a short distance a grade of 7 or 8 per cent., then instead of subordinating that entire line to this fact and putting on motors unnecessarily heavy for all ordinary conditions of work on the cars, it would seem advisable to equip the line for its nominal duties and at the excessive grade put in some additional source of traction. This would be found to be cheaper and more satisfactory.

Mr. Thurston says: "You have given some of the disadvantages of the conduit and storage battery systems; are there none to the overhead system?" Unquestionably there are. There is, as I have said, the unsightliness of all overhead wires; there is, of course, the possibility of a wire breaking, but if properly put up this ought not to occur. It must not be understood that I am here to promote or to advocate any particular system. I am just as firm a friend as anyone can be of the storage battery, and hope just as much for its success as anyone can, but I do not want to take the position of claiming more for any system than it can in honesty hold.

In regard to putting the motors upon cars, it would seem to me that, although greater care must be exercised in the construction of the motor, the proper place for it is under the car, out of sight. My own opinion and experience is that each axle should be equipped, in the case of a four-wheel car, and each truck, in the case of an eight-wheel car. Both because of the increased traction.

Not only ought they to be equipped but independently equipped, because in this way greater traction and much greater certainty of operation is secured on the track in bad condition, and especially in order not to obstruct the track because of any accident. Of course the object of everyone should be to make as little change as possible in the recognised and accepted features of street cars, and in the application of motors to the cars absolute certainty of operation of axles, and flexibility so as to stand the shock of constant strains, should be sought after.

While the convention was in progress Mr. C. J. VAN DEPOELE was called upon to address the delegates. He thereupon spoke briefly on:—

THE ELECTRIC RAILWAYS IN AMERICA.

To illustrate what had been and could be done, Mr. Van Depoele outlined the work of his own company, and his statements may be summarised as follows:—

Location.	Miles.	Cars.	Power.	Total power cost per day.
Windsor, Ont.	2	2	Steam, rented.	$4.00
Detroit, Mich.	2	8	Steam, rented	6.00
Appleton, Wis.	5	5	Water.	4.50
Port Huron, Mich. ...	5	5	Natural gas.	2.00
Scranton, Pa.....	4½	7	Culm.	7.00
Binghamton, N. Y. ...	5½	6	Steam, rented.	10.00
Lima, O.	4	6	Crude oil.	4.00
St. Catherines, Ont....	6	6	Water.	3.00
Montgomery, Ala.....	13	18	Steam.	14.00
Total	47	63		

In addition to these roads in operation Mr. Van Depoele has the following under construction:—

Location.	Miles.	Cars.	Power.
Jamaica, L. I.	6	10	Steam.
Ansonia, Conn.	3½	4 and 1 loco. of 75 H.P.	Water.
Omaha, Neb.	7	10	Steam.
Dayton, O.	6	12	Steam.

Mr. Van Depoele stated that in no case did he reckon on less than 18 hours a day. In reply to various questions, he said he preferred one motor. It could be put on the front platform, where it could be seen and watched. In most cases it was sufficient to connect up with the front axle, but where heavy grades had to be ascended they belted from that back to the second. As to protection of the overhead circuit, they now placed a guard wire. Of course if telegraph or telephone wires unprotected by lightning arresters came in contact with the main, it was so much the worse for them and the office they ran from. The noise of an electric car was certainly no greater than that of an ordinary car, and should be less than that. The depreciation of the machinery was not in excess of 2 per cent. per annum if it was properly attended to. At Dayton, O., part of the circuit would be conduited, the conduit being 9 inches above the cross-ties, giving a gentle slope, as in cable roads, so as to drain easily away from the conduit. He thought a good conduit could be put in for $5,000 or $6,000 a mile. Speaking of grades, he mentioned that in Appleton there was a 10 per cent. grade, with a curve of 60 feet. Grades of 7 and 8 per cent. could be taken, provided there was a good sand box used. In Scranton they had grades of 7 and 8 per cent. As to trouble from sleet, &c., on the overhead conductors, he said that at first they had anticipated great trouble from this. In Scranton, for instance, although they had side guards on the trolley to break the ice, on one occasion it looked pretty bad. But the difficulty disappeared as soon as the car started, as the current passed through the ice easily and the trolley kept to the conductor. Every now and then there was a little flash, but that was all. With 25 cars in parallel on a double track he would use ¾ inch copper for each conductor, connecting them together so as to lessen the resistance and get the higher conductivity. The current per car he found to average about 10 ampères, but it would now and then go up as high as 25 or 30 ampères. He used a potential of 500 volts.

ELECTRICAL DISTRIBUTION BY ALTERNATING CURRENTS.*

By M. M. SLATTERY.

ONE short year ago the commercial success of the branch of electric lighting in which induction coils are used was by some of our best authorities considered very problematical, but practical use of the induction system has not only succeeded in commercially converting high tension electricity to low tension for electric lighting purposes, but also high tension theoretical opponents by practical demonstration of facts.

Upon the occasion of the last convention, the extensive use of the induction system received its first authoritative endorsement by our esteemed friend Dr. Otto A. Moses, and although he was by some considered over enthusiastic in his statements, time has served to prove the correctness of his views and the realisation of many of his anticipations.

We will go back six months, and mentally, what do we see in this business from here? A few experimental plants scattered

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* Report of Committee of the American National Electric Light Association, presented at the Boston meeting, August 9th, 1887.

about in various parts of the country struggling for public recognition and with the innumerable detail difficulties, which dog the footsteps of every new departure; difficulties, the magnitude of which are usually in proportion to our ignorance of their nature, and therefore, more frequently than not, unduly magnified.

Now what have those difficulties been, and has the past six months' experience enabled the manufacturing companies engaged in this branch of business to eliminate them?

We find there were three factors in the induction system that required all the ability of the electrical engineer to work out and place upon a proper footing, namely, the dynamo machine, the induction coil and the disposition of the external circuit to take the best advantage of the use of the induction coil.

Of course, there were alternating dynamos in existence, as were also induction coils before this lighting branch of business had acquired any prominence, but they were not such as would meet the new requirements.

We will first take the dynamo. It will be familiar to all of you, that no matter how intimately acquainted you may be with the construction of dynamo machines, when you start in to build a new type, your previous experience, however valuable it may be, does not enable you to foresee innumerable detail difficulties which will assuredly develop with practical use, and which take time to ascertain and remedy.

Well, so far as we have been able to learn the weaknesses which developed in this apparatus were first, the liability of the current to jump across the coils in the event of the field being excited with the armature circuit open. This open circuit sometimes happened by a dead cross occurring in some place in the mains, blowing the fuse at the dynamo, thus opening the circuit, and then the field being fully excited the armature would generate an exceedingly high electromotive force for an instant; the current under the circumstances would be very liable to jump across the coils of the armature, and other hurtful effects to the machine would ensue; the remedy for that was inserting at every branch in the external circuit a junction fuse, and at various points along the mains and sub-mains section fuses to such an extent as to make an open main a remote contingency. It was also found that the armatures heated excessively owing to the presence of the plaguey Foucault currents. It was found that this evil could be almost wholly suppressed by building the armature without iron, and avoiding as much as possible the use of masses of metal in proximity with the armature coils. In this connection Siemens's early type of alternating dynamo, slightly modified to meet the new requirements, might read us a lesson.

It was a bold step when the alternating dynamos were constructed with iron cores, and those who make this class of machine for this high tension incandescent business might give us some interesting information. To my mind this iron core construction speaks of disagreeably high temperature. I do not say that they will not be able to present a rational theory why this evil may not be, or has been, greatly modified, but the fact existed in the past, and as far as we have been able to ascertain stands refuted at present. One thing, however, is pretty evident, that just now this type of machine appears to be finding a rather extensive use, evidencing that it must be doing good work. So much for the alternating current dynamo, a machine destined to play a most important part in the future electric lighting business, and in the light of past experience no doubt should exist in the minds of anyone here that these dynamos in practical use are now almost, if not quite, as reliable as any other dynamo; while coupled with this is the important factor of a pretty close self-regulating property attainable in this system, without the necessity for any particular method of winding, that property following chiefly as the result of the use of the induction coils. It is satisfactory to know that during the probation of this system every accident of any importance which has occurred to the dynamos has been of a purely mechanical nature, and our mechanics have reduced them to a minimum.

No doubt the induction coils have been the source of considerable anxiety, not because there was any obstacle in the way of obtaining high electrical efficiency, as this latter appears not to have been by any means a difficult problem to solve. The source of greatest trouble has been, as far as I can learn, that of insulation. In what form will the weakness appear? has been a question often asked himself by a timid electrician and as usual the most unlooked for troubles developed. At one time an unaccountable defect in the insulation of the secondary coil would occur, cutting out a number of convolutions, thereby causing annoyance by reducing the incandescence of the lamps in its circuit; the remedy was simple—increase the insulation of the wire and exercise still greater care. The same accident would still more frequently happen to the primary coil; the same remedy applied overcame it; sometimes a number of the layers of the primary coil would thus be suddenly cut out, resulting in the passage of a much heavier current than the fuse in the coil box had carrying capacity for; the fuse would then melt and possibly draw an arc that you had a great deal rather do without if you could; the remedy for this was, keep on insulating the primary coil layers from each other until the trouble ceased, and increase the distance between the ends of the primary fuse to such an extent that when the latter melted, an arc, no matter how great its volume, would not be able to bridge over the distance which, after all, was calculable because the E.M.F. was constant. Then, again, metallic contact would take place between the induction coil and the iron box in which it was mounted, and if that box happened to be placed anywhere near a ground, possibly unpleasant electrical experiences might be related in wet weather. It was again only a question of looking out for the insulation to reduce such defects to a minimum; well, the insulation appears to have been looked out for, as the smooth and safe working of that branch of the business would now seem to testify, and to-day that part of the system can be made as reliable, simple and as easily disposed of as any other part of an incandescent system.

Thus the two new and troublesome factors have gradually and surely been strengthened for their future work.

The next in the system, viz., that method of distribution which would enable you to utilise the induction coil to the best advantage, although apparently presenting the simplest problems at the outset, has required a great deal more thought than was anticipated. It was found that no particular rule, as in the case of low tension distribution, could be carried out, the methods of distribution varying with the condition of the district in which you had to distribute. In some cases the wires were run out from the central station through the centre of distribution, and tapped at any point along the route where lights were required. This was the earliest and simplest form of distribution, and answers perfectly well for comparatively small installations, it being desirable to keep the loss in the mains down to about two per cent. and perhaps about two to three per cent. in the induction coils, so that the incandescence of the lamps should not vary appreciably throughout the system; this arrangement of the circuit may be carried out in small and very scattered towns, where it has been found to answer admirably. In other cases, where the district is more densely populated and a large installation is required, the inductoriums are placed in the centres of distribution and used like so many stationary dynamos, the high tension primary current with comparatively small conductors feeding each of these centres, the secondary or distributing circuit being taken where lights are required; still other methods of distribution are carried out, but what has been stated in this connection will serve to show that again the past year's familiarity with the business has given an opportunity to perceive and profit by many advantages the system offers.

One of the last but by no means the least point that I shall touch upon in this interesting subject is the question of comparative cost of the main conductors required in installation of an induction, and low tension incandescent plant. Not at all infrequently we shall find ourselves called upon to figure upon a plant like this.

From the source of generation to the point of distribution is one mile and a half, making a three-mile circuit; at the point of distribution you are required to distribute some 400 16-C.P. lamps at say 5 per cent. fall of potential, which appears to be about the limit allowed the induction system. The necessary conductors for this purpose in the induction systems now in use would be No. 2 Brown and Sharp, which will cost about $230. In the case of the low tension installations upon the low tension system, you would require a conductor costing about $1,050.

Should you be required to distribute throughout the whole of the length of the circuit, the wire such as is used for ordinary arc lighting purposes would be amply sufficient for the induction, and, of course, a proportional reduction may be made in the low tension.

Now, a great many exaggerated statements are made with regard to the dangerous shocks to be expected from this alternating current, and while I am not prepared to say that the physiological experience of a shock from a thousand volt dynamo is the most agreeable thing in the world, I am prepared to say that the shock is by no means as severe as that received from a continuous current dynamo of the same voltage. A few weeks ago a man showed me his hands, which were horribly burned. He had received a shock from an eleven hundred volt dynamo, and he said with a visible tremor in his arms, as if the recollection of that shock was still vividly impressed upon his mind, that he experienced the effect of that shock for more than a week afterward. A friend of mine was testing a 400-light 1,050 volt alternating dynamo, fully loaded, only a few days ago, and going towards the machine his foot slipped and he fell quite close to it; in his confusion he quickly reached out his hands and unfortunately placed them directly upon the poles of the dynamo. He said from where he fell to the wall behind him was about 15 feet, and it seemed to him as if that dynamo was suddenly converted into an electrical gun, and he got shot across the room until the velocity of his movement was interfered with by the wall. There was scarcely the appearance of a burn on his hands, merely a pin's head matter, while the effect of the shock was felt by him only for a few hours. It might be said that the difference of the effect of the shock was owing to the difference in the temperament of the two men; that may be so, but I have received three pretty severe shocks from a 1,000 volt alternating machine, and however much I may have felt inclined to dispense with the shaking up it gave me the experience has been of value to me—one cannot have everything.

One word more in conclusion. The induction system has evidently come to stay, not because enthusiastic advocates think or say so, but because the expert public, the central station public, have practically endorsed it, because it more nearly than anything else meets their immediate and anticipates many of their future requirements. More especially is its advent doubly welcomed just now with this misconducted overhead conductor warfare pressing on every side, and which is every day acquiring seriousness in proportion to the increase of copper wire in the air, and I think that this system, with its comparatively small mass of conductors, will postpone for a considerable time the necessity of going underground with the electric light wires until more

extended experiments shall have given us the confidence in underground systems that experience in the past has materially shaken.

DISCUSSION.

Mr. SLATTERY: If I might make a suggestion, sir, we have our old friend Mr. Duncan present, who is fully charged with alternating effects this afternoon, and we shall be very pleased to receive a shock from him.

Mr. DUNCAN: In regard to the alternating current system, I have simply to say that there is no question about the practical and efficient working of that system. There is no question about the covering of a given space and the distribution of a large number of lights much more economically than there is in a direct system. Now, as to the question that comes up in regard to the difficulties suggested by Mr. Slattery, those are questions which are gradually working themselves out as he stated in his excellent paper. One of the difficulties which was first experienced, as he says, was the induction box itself, but practical experience of four months in the use of that box has been such as to show that in every respect it is entirely efficient, entirely satisfactory, and that it can be relied upon to be placed in any position to do its work effectually and efficiently. In regard to the dynamo, he has gone through that part of it. There is some heat naturally generated from any dynamo. I do not know that I can say that we get any more heat from the alternating current dynamo than we do from the regular arc light dynamo; I do not think we get much less; I know we do not get a great deal more. In the heating of the parts in the original machines that were made there was considerable difficulty. Insulation has been improved from time to time, and at the present time I know of machines which have run successfully for three months, to which nothing has ever been done. Some of these machines will average in a week's run twenty-four hours per day except Sunday, and they will be shut down on Sunday for about two hours. In regard to the efficiency of the system, I am satisfied myself, from my own knowledge and from the experience we have had with it, that for long distance lighting, for doing city lighting, for covering a straggling community where the lights will be necessarily very much scattered and where it is not a compact part of the city like most centres, that you can do it more efficiently and more economically with that system than you can with the direct.

Mr. SMITH (Allegheny City Electric Light Company): I would say that I have had some experience with the alternating system in the same company with which Mr. Duncan is connected, and also with another company in Philadelphia, where we started first with the direct system and changed it to the alternating. On some of the points which Mr. Slattery has asked for I may be able to give him some information. We have found that where we are using the converter system its enormous flexibility enables us to apply almost any system we want. In one of our stations in Pittsburgh, where we rent lights in a poor neighbourhood, where the majority of places would demand three or four or five lamps, we found it cheaper to place the converters on the place, using either 50-volt or 100-volt lamps, as we pleased. In the other parts of the town, where we found buildings taking ten, fifteen, or twenty lights, we found it better to take the high tension right into the building and place the converter in the cellar or the garret. In some cases we have a mixture of the systems. For watchmen's lights we have both the secondary main outside and the coverters directly in the building. In very large buildings we carry the high pressure mains over the buildings; that is, through the building, and tap to our converters wherever convenient. In the case of hotels, we have a high pressure wire down to the centre of the corridor, and in the case of a large parlour being lighted, we would put a converter into that parlour. In the case of a row of bedrooms requiring twenty lights, we would put in a twenty-light converter. Without the slightest trouble we change buildings having three or four hundred lights from one system to the other without cutting off the lights for a moment, by cutting up the existing wires in the sections and tapping in the converters one after another as we need them. Whenever we wished to change a section we would substitute our 50-volt lamps for 100-volt lamps. When we had all the lamps changed in a building we would splice up where we had cut. In a building having 300 lamps we only put in converter capacity for 200, knowing that no more than 200 lights would be burned at one time.

As regards the danger of shocks, I have had a little experience on both sides. I have had a full share of the arc light shock. I opened a circuit of 1,500 volts, which was sufficient for me. I have also taken a thousand volts alternating, and there is no comparison between the shocks at all. If I may be allowed to give my own experience, I should say that the Thomson-Houston machine gives about the most tremendous blow I have ever felt. It is a peculiar dead stroke which you do not find in the Brush. But the alternating machine seems to throw you off instantly; you do not have time to take hold. We had a case in Philadelphia the other day which I think will be something for Mr. De Camp to hear, as I believe he feared it was one of his men. (Mr. Smith then related the case of a man who had accidentally taken hold of a lamp socket and completed the circuit through the damp ground on which he was standing. He lay with the 1,000 volt alternating current passing through him for four minutes before assistance arrived. Although blue in face and greatly prostrated, he was resuscitated by resort to artificial respiration. The structure of the skin had been destroyed, as is usual in all electric burns, and the burn had extended some distance under the skin and had followed two or three inches under the skin. The man said afterwards that for two minutes at least of the time he was on the wire he was perfectly conscious, that he knew his companion was there and he tried to tell him to pull the wire away, but he could not speak, and that when his companion went away he knew perfectly well he had gone for assistance, and then realised that it would be three or four minutes before he got back, and he thought to himself that he could not stand it that length of time, and then he forgot everything. He said that he felt no particular pain. He got a shock that he would get from any electric current, when he first laid hold of it, but after that he felt nothing. The sensation seemed to be like that of drowning.) As soon as we got him to gasp and breathe, the colour came back again. This incident has given me quite a new hold on the alternating current system—to know that you can take 1,000 volts of it and stay on it that length of time. I know I should be very sorry to take a direct current, one quarter of that time.

As to the question of heating up of the machines, I would say that on the newer machines, such as we are using now, we run them for a week, starting on Sunday afternoon and running until Sunday morning. It runs from nothing—an amount which you cannot read—to 35 or 40 ampères, and in all time it never gets so hot that you cannot bear it with your hand with comfort. Of the larger size machines we are using in Pittsburgh, we have one there that has been running two months—a 30-light machine, running 22¾ hours a day. We only stop for 10 minutes, and if the engineer does not feel like it, he does not stop even then. The load on that varies from nothing up to 65 or 70 ampères. You can always bear your hand on the machine, and as long as you can bear your hand on it is certainly not hot enough to injure any good insulation. The converters we know absolutely nothing about. We put them in and that is the end of it. I think we had to take two out on account of the blowing out of the plugs. The secondaries were short-circuited, the effect of which is generally to blow out the primary plug. It does not injure the converter as far as we have been able to find. We have never had a case of a converter short circuiting either in the primary or the secondary. We have occasionally had a converter terribly overloaded, when it will heat up and finally blow the plugs through another converter, which is tapped in on the secondary wire. It is hard to get linemen to understand that where two converters are coupled together and one of them gets hot it is usually the other converter that is at fault. I am a little of an enthusiast on the subject of alternating currents as in Pittsburgh we are using the direct system multiple arc, and we have been struggling with No. 0000 wire pulling our poles out of line and the direct current machine burning armatures. In Pittsburgh we put them to very severe duty, owing to the suddenness with which storms come up there. I have known a current in our station to jump from 300 to 2,000 ampères inside of 15 minutes. But taking the two systems into account, the ease of distribution and the ease of handling, I say that the alternating system is bound to come, if for nothing else, for the enormous reduction it makes in the cost of running your station.

Dr. MOSES: I am very well pleased to hear some of the details Mr. Smith has mentioned. I feel myself a little responsible for the success of that system, inasmuch as I then thought it would succeed, and now I want it to succeed. The alternating current machines which I saw at Pittsburgh were running very well, and had only been running for one month when I made that report to the last convention—as my neighbour facetiously remarks, "that very extraordinary report." However, I have just returned from abroad, and thought that before coming here I could not spend the few days necessary to get over the *mal de mer* better than in going to Pittsburgh and seeing how that machine was running. I am very happy to say that the same machine is running in that station in South Pittsburg that Mr. Smith speaks of, with this additional fact, that they have doubled up all around in their capacity—not doubling, however, that lone, solitary man that Mr. Weeks saw there when he meandered through Pittsburgh and looked at the alternating current system. The same man was there. They had doubled up the capacity, but that same one man was running it, and I did not see that he had any more work to do than he had before. They were running 3,000 lights where before they had been running 1,500. While wandering through Pittsburgh and seeing thousands and tens of thousands of incandescent lights which they have about in all directions, I noted the progress that had been made by the principal company there engaged in the alternating current system, and I saw one thing there that I would like to call to the attention of this convention as being one of the most important things in connection with the development of alternating electric lighting that I have yet seen or heard of. When I went there six months ago they were making machines of 500 to 1,000 lights. The other day when I went up there, I saw a 2,500-light machine running and doing its work admirably well, and here is the thing that is so remarkable and that I will call special attention to. The machine simply seemed to have been looked at through glasses of gradual magnifying power; that is to say, the 500-light machine was of a certain size, the 1,000-light machine so much larger, and so on; but it is exactly the same machine in all its details. In a continuous-current machine, if you want to vary the output of the machine by increasing the parts, you will find yourself, when you begin your work, quite at sea. No one can calculate exactly what he is going to get at. True, there is a good deal of pleasure in guessing right, but if you do not happen to guess right it is very disagreeable and costly. But here in the alternating current machine you see a possibility,

under certain forms of the machine, of quadrupling the output without changing the form of the machine at all. Now, where is that going to stop? It is only a step to say that they will be making some day, in the simplest manner, 10,000-light machines, that will require no more attention than the same solitary man that we saw at the South Pittsburgh station. The strength of the materials is the only limit to the length of the shaft bearing the armature, and I do not see really where the limit is going to be; so, if you want to put in central station work, it seems to be that on an alternating current machine you may do an unlimited amount of work and get rid of all this great trouble you have had in doubling up machines, looking after commutators and all that difficulty which naturally limits the life of a plant. That is a fact that I think will be of value to the convention, and I give it.

Mr. KIMBALL: In regard to the alternating system of supplying incandescent lights, since the last convention in Philadelphia, there has been a marked advance, and from the various installations which are at present in operation we have been able to get data which are not only interesting, but useful, and the question of insulation of the high potential wires is one which appeals to everyone in every part of electric lighting stations, whether in the lineman or the central station general manager. In one case it is life and limb; in the other it is property. Regarding the danger of carrying high potential wires into sockets, there are many cases where it is convenient to make an armature instead of putting a converter high up on a fixture in a city where you are not allowed to put it on poles—it is very inconvenient to put a converter for 100 lights on top of a man's building and carry one or two down into a store to distribute the incandescent light, simply because you are running with 52 volts; and if a way can be devised for enabling us to carry safely the currents which, to say the least, approach the intensity of the arc current into our cellars without that sense of danger, it is the thing that is needed at present. The question of the insulation between the primary and the secondary of the induction coil is one which is governed by a variety of circumstances. Where converters are placed out of doors, moisture will get in and grounds will develop on the high tension wires, no matter how carefully the poles may be wired, either from defective wiring as far as relative insulation in positive and negative wire; or possibly we may have ground wires, and this bold expedient of grounding the inside wiring by heavy metallic lines to the ground has been brought to the attention of this convention before, and has been published in some of the electrical papers, and it seems to me that opens a field for discussion. The fact must be appreciated that each system of incandescent wiring from a converter inside a building is entirely separate and completely isolated from every other piece of wiring in the city or town, and that running a metallic ground from one wire to the earth is not to be compared with grounding a positive wire by distribution from 75 or 100 volts; and in such cases should danger develop, being only on one wire, the lead fuse can give way to an excess of current on either positive or negative without in any way affecting the other installation, and in such way give warning of the danger whether in the converter or in defective wiring. Regarding the distribution of currents over a large area, in discussing a system of running incandescent lights which requires us to use a little different apparatus, it seems to me that those of us who have the practical work to do are apt to lose sight of the fact that all the laws of wire and construction work which apply to straight incandescent or low tension wiring are applicable to the alternating system, and that all appliances which are made for straight incandescent work may be utilised for the alternating current by conforming to the laws which are now so well known regarding self-induction and the closed magnetic shield; and it is a question to be decided by the electric light engineers in practice, to determine whether it is better to rely on high potential wires for a system of distribution, and lay them out with as much care as the feeders, mains and systems are now laid out, and then to place the converters as near the lamps as possible—any way they may be required; or whether it is better to run a system of high potential mains and rely on your inside wiring or your placing of your converters.

Mr. SMITH: I would state that I am not in any way a representative of the Westinghouse people though using their apparatus, but being in the same city as the manufacturers, I have had exceptionally good opportunities for observing their work. In Philadelphia we are using lead and copper cables. We use that because it seemed to us in underground work that the first thing we had to look out for was moisture. We satisfied ourselves that if we could get a good metallic covering it would be probably about as good as anything we could get hold of. Our conduit in Philadelphia is made of a common pine box, in which the cable is laid, and the box is filled with pitch. In that we have iron junction boxes for connecting our feeders into our mains. The outside covering of the cable is not insulated in any way from the junction box, though, of course, the wire carrying the current is. In some parts of the street where we found it difficult, owing to water pipes, the cable car conduits, and so on, to lay a wooden box, we used the iron pipe through which we pulled these cables and then filled them up with pitch. We filled them up with pitch simply as a mechanical protection to prevent workmen from hammering a pick into them. We have not had the slightest trouble or loss of current or induction or anything else. Our men handle the outer covering of this cable with perfect impunity, and as long as your dielectric is in good shape it seems to me you have something that is perfectly safe. I understand that some experiments have been made by the Westinghouse Company with regard to this very question, and when I put to them the question their answer was that we could use any kind of cable we wanted to as long as the covering was good, but for practical use they would recommend us in this particular instance a lead-covered cable having both conductors in the one light covering; that is to say, two separate cables run side by side through their whole length. And that is the form of cable I have been advocating myself for mechanical reasons. They tested it thoroughly in every way, and told me I should get perfect satisfaction out of it. When we turned the alternating current into our Philadelphia lead-covered cable where the cables are run in separate boxes, but grounded throughout their whole length, the question was raised whether static charges would not come into effect and our men get shocks. But we did not find that there was any effect whatever. As to the question of loss of power through induction passing through a metallic covering it might be different with iron. As I say, I have had no experience with long conduits of iron; but it seems to me that if you run your wires close together, any effect you get on one wire when it is positive, would be neutralised the next instant. It is the same way with telephone wires. We have found that if we cross our wires every four or five poles we have no effect whatever in the telephone. In one case, we have the double circuit about 12 inches apart and the telephone wire running on top of the pole, about 7 inches between each wire. There is a continuous musical note, but not nearly as annoying as the buzzing caused by an ordinary arc machine current. We, of course, think that the telephone companies ought to cross their wires, but we do not think we ought to be called upon to be public benefactors to such an extent.

Mr. KINSMAN: Since I came in I have heard one or two gentlemen speak of the information they cared to supply in regard to this alternating system. I would like to add one thing that may be of interest. I have succeeded perfectly in burning an arc light with a 50-volt converter from the alternating system of the Westinghouse people. We get 12 hours from 24 inches of carbon, and a light that is perfectly steady.

Mr. SMITH: I would like to ask Mr. Kinsman what is the style of the arc lamp.

Mr. KINSMAN: It was a simplex lamp, 2,000 candle, 55 volts.

SPECIFIC INDUCTIVE CAPACITY.*

By J. HOPKINSON, M.A., D.Sc., F.R.S.

THE experiments which are the subject of the present communication were orginally undertaken with a view to ascertain whether or not various methods of determination would give the same values to the specific inductive capacities of dielectrics. The programme was subsequently narrowed, as there appeared to be no evidence of serious discrepancy by existing methods.

In most cases the method of experiment has been a modification of the method proposed by Prof. Maxwell, and employed by Mr. Gordon. The only vice in Mr. Gordon's employment of that method was that plates of dielectrics of dimensions comparable with their thickness were regarded as of infinite area, and thus an error of unexpectedly great magnitude was introduced.

For determining the capacity of liquids, the apparatus consisted of a combination of four air condensers, with a fifth for containing the liquid arranged as in a Wheatstone bridge, fig. 1. Two, E, F, were of determinate and approximately equal capacity, the other two, J, I, were adjustable slides, the capacity of either condenser being varied by the sliding part. The outer coatings of the condensers E, F, were connected to the case of the quadrant electrometer, and to one pole of the induction coil, the outer coatings of the other pair, J, I, were connected to the needle of the electrometer and to the other pole of the induction coil. The inner coatings of the condenser, J, F, were connected to one quadrant, and I, E, to the other quadrant of the electrometer. The slide of one or both condensers, J, I, was adjusted till upon exciting the induction coil no deflection was observed on the electrometer. A dummy was provided with the fluid condenser, as in my former experiments, to represent the necessary supports and connections outside of the liquid. Let now x be the reading of the sliding condenser when no condenser for fluid is introduced, and a balance is obtained. Let y be its reading when the condenser is introduced fitted with its dummy, z when the full condenser is charged with air. Let z_1 be the reading when the condenser charged with fluid is introduced, then will K, the specific inductive capacity of the liquid, be equal to $(y - z_1)/(y - z)$.

Three fluid condensers were employed, one was the same as in my former experiments.† Another was a smaller one of the same type arranged simply to contain a smaller quantity of fluid. The third was of a different type, designed to prove that by no chance did anything depend on the type of condenser; this done it was laid aside as more complicated in use.

To determine the capacity of a solid, the guard-ring condenser of my previous experiments‡ was used. Advantage was taken of the fact that at the time when there is a balance the potentials of the interiors of all the condensers are the same. Let the ring, O, of the guard-ring condenser be in all cases connected to J, let the inner plate of the guard ring be connected to J, as in fig. 2,

* Read before the Royal Society on Thursday, November 17th, 1887.

† "Phil. Trans.," 1881, Part II. ‡ "Phil. Trans.," 1878, Part I.

and let a balance be obtained. Let the inner plate be now transferred to I as in fig. 3, and again let a balance be obtained; the difference of the two readings on the slide represents on a certain arbitrary scale the capacity of the guard-ring condenser at its then distance.

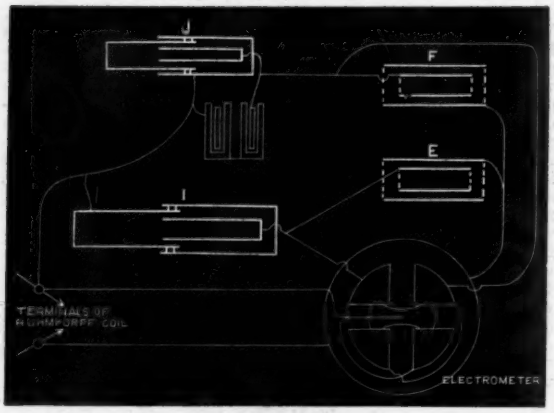

FIG. 1.

In some cases it was necessary to adjust both condensers to obtain a balance, then the value of a movement of the scale of one condenser in terms of the other was known from previous experiment. In some cases it was found most convenient to introduce a condenser of capacity known in divisions of the scale of the sliding condenser coupled as forming part of the condenser, J. The old method of adding the opposite charges of two condensers, then connecting to the electrometer and adjusting until the electrometer remained undisturbed, was occasionally used as a check; it was found to give substantially the same results as the method here described when the substance insulated sufficiently well to give any results at all.

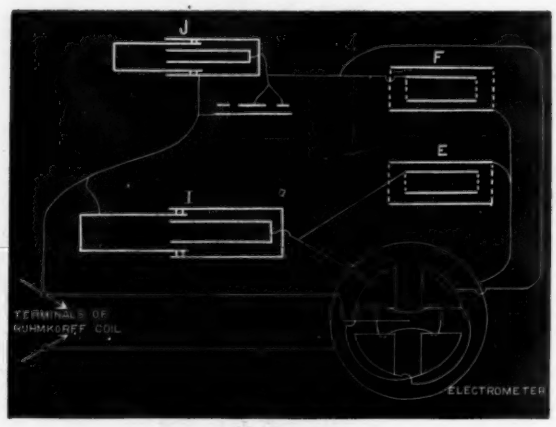

FIG. 2.

Colza Oil.—This oil had been found not to insulate sufficiently well for a test by the method of my former paper. Most samples, however, were sufficiently insulating for the present method. Seven samples were tested with the following mean results:—

No. 1. This oil was kindly procured direct from Italy for these experiments by Mr. J. C. Field, and was tested as supplied to me—

$$K = 3{\cdot}10.$$

No. 2 was purchased from Mr. Sugg, and tested as supplied—

$$K = 3{\cdot}14.$$

No. 3 was purchased from Messrs. Griffin, and was dried over anhydrous copper sulphate—

$$K = 3{\cdot}23.$$

No. 4 was refined rape oil purchased from Messrs. Pinchin and Johnson, and tested as supplied—

$$K = 3{\cdot}08.$$

No. 5 was the same oil as No. 4, but dried over anhydrous copper sulphate—

$$K = 3{\cdot}07.$$

No. 6 was unrefined rape purchased from Messrs. Pinchin and Johnson and tested as supplied, the insulation being bad, but still not so bad as to prevent testing—

$$K = 3{\cdot}12.$$

No. 7. The same oil dried over sulphate of copper—

$$K = 3{\cdot}09.$$

Omitting No. 3, which I cannot indeed say of my own knowledge was pure colza oil at all, we may, I think, conclude that the specific inductive capacity of colza oil lies between 3·07 and 3·14.

Prof. Quincke gives 2·385 for the method of attraction between the plates of a condenser, 3·296 for the method of lateral compression of a bubble of gas. Palaz* gives 3·027.

Olive Oil.—The sample was supplied me by Mr. J. C. Field—

$$K = 3{\cdot}15.$$

The result I obtained by another method in 1880 was 3·16.

Two other oils were supplied to me by Mr. J. C. Field.

Arachide.—$K = 3{\cdot}17$.

Sesame.—$K = 3{\cdot}17$.

A commercial sample of *raw linseed oil* gave $K = 3{\cdot}37$.

Two samples of *castor oil* were tried; one newly purchased gave $K = 4{\cdot}82$; the other had been in the laboratory a long time, and was dried over copper sulphate—

$$K = 4{\cdot}84.$$

The result of my earlier experiments for castor oil was 4·78; the result obtained subsequently by Cohn and Arons† is 4·43. Palaz gives 4·610

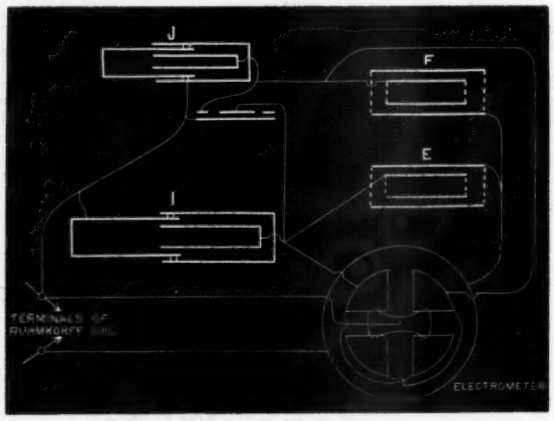

FIG. 3.

Ether.—This substance as purchased, reputed chemically pure, does not insulate sufficiently well for experiment. I placed a sample purchased from Hopkin and Williams as pure, over quicklime, and then tested it. At first it insulated fairly well, and gave $K = 4{\cdot}75$. In the course of a very few minutes $K = 4{\cdot}93$, the insulation having declined so that observation was doubtful. After the lapse of a few minutes more observations became impossible. Prof. Quincke in his first paper gives 4·623 and 4·660, and 4·394 in his second paper.

Bi-sulphide of Carbon.—The sample was purchased from Hopkin and Williams, and tested as it was received—

$$K = 2{\cdot}67.$$

Prof. Quincke finds 2·669 and 2·743 in his first paper, and 2·623 in his second. Palaz gives 2·609.

Amylene.—Purchased from Burgoyne and Company—

$$K = 2{\cdot}05.$$

The refractive (μ) index for line D is 1·3800,

$$\mu^2 = 1{\cdot}9044.$$

Of the benzol series four were tested: *benzol*, *toluol*, *xylol*, obtained from Hopkin and Williams, *cymol* from Burgoyne and Company.

In the following table the first column gives my own results, the second those of Palaz, the third my own determinations of the refractive index for line D at a temperature of 17·5° C., and the fourth the square of the refractive index:—

			μ	μ^2.
Benzol	2·38 ...	2·338 ...	1·5038 ...	2·2614
Toluol	2·42 ...	2·365 ...	1·4990 ...	2·2470
Xylol	2·39 ...	— ...	1·4913 ...	2·2238
Cymol	2·25 ...	— ...	1·4918 ...	2·2254

For benzol Silow found 2·25, and Quincke finds 2·374.

The method employed by Palaz is very similar to that employed by myself in these experiments; but, so far as I can ascertain from his paper, he fails to take account of the induction between the case of his fluid condenser and his connecting wire; he also supports the inner coating of his fluid condenser on ebonite; and, so far as I can discover, fails to take account of the fact that this also would have the effect of diminishing to a small extent the apparent specific inductive capacity of the fluid.

* *La Lumière Electrique*, Vol. 21, 1886, p. 97.

† "Wiedemann's Annalen," vol. 28, p. 474.

Possibly this may explain why his results are in all cases lower than mine. Determinations have also been made by Negreano ("Comptes Rendus," vol. 104, 1887, 423) by a method the same as that employed by myself.

Three substances have been tried with the guard-ring condenser—double extra condensed flint-glass, paraffin wax, and rock salt. The first two were not determined with any very great care, as they were only intended to test the convenience of the method. For double extra dense flint-glass a value 9·5 was found; the value I found by my old method was 9·896. For paraffin wax 2·31 was obtained—my previous value being 2·29. In the case of rock salt the sample was very rough, and too small: the result was a specific inductive capacity of about 18, a higher value than has yet been observed for any substance. It must, however, be received with great reserve, as the sample was very unfavourable, and I am not quite sure that conduction in the sample had not something to do with the result. In the experiments with the guard-ring condenser the disturbing effect of the connecting wire was not eliminated. My thanks are due to my pupil, Mr. Wordingham, for his valued help in carrying out the experiments.

THE SCHANSCHIEFF BATTERY AND LAMPS.

AT the offices of the Schanschieff Electric Battery Syndicate there are at the present time some interesting illustrations of the various lamps and systems of lighting for which it is claimed that the Schanschieff battery is pre-eminently suitable. The practical uses to which the battery can be put include certain purposes in connection with which there is a crying demand and an almost unlimited field for electric lamps of satisfactory construction and performance, notably for miners' use and for railway carriages and theatres. To meet the particular requirements in these and other cases, considerable ingenuity has been exercised, and the collection of samples now on exhibition is comprehensive and complete, as the following description will, to some extent, indicate, though we can hardly hope to give an exhaustive account of the numerous forms shown.

To begin with the miners' lamps, it would appear, from an inspection of the several forms which are manufactured, that a successful effort has been made to meet all demands. The chief requisites in a lamp of this class are simplicity of construction, so that any working man can easily attend to it with little loss of time; freedom from liability to explosion, combustion or ignition, so as to be perfectly safe while in use; and that it must not be much heavier than the lamps now used. Lamps for this purpose are shown in several sizes and arranged in different ways to meet special circumstances. A round lamp, 4 inches in diameter and 4 inches high, containing 3 cells, and requiring a charge of 15 ozs. of liquid, will afford a light of nearly 2 C.P. for at least 8 hours. The consumption of zinc in this form of battery has been found to be $\frac{3}{8}$ lb. in 24 hours, which equals a cost of $\frac{1}{2}$d. per shift of 8 hours. It is stated to give four times the light of a Clanny lamp, and to weigh only a mere trifle more. The 4-cell lamp is 5 inches in diameter, $4\frac{1}{2}$ inches high, takes 20 oz. of fluid, lasts for 9 hours at a cost of $\frac{3}{4}$d., and gives seven times the light of a Clanny lamp. There is also a large 4-cell battery 5 inches in diameter and 6 inches high, taking 24 ozs. of fluid, lasting from 10 to 11 hours, and costing about one penny per shift. These lamps can be opened, recharged and closed in a few seconds by means of a lever lift or a fixed screw lift, working on a central rod; the lamp is enclosed in an outer cap of thick glass almost unbreakable, but which can, if desirable, be further protected by a wire frame.

As an illustration of the readiness with which any special requirement can be met, it may be mentioned that quite recently a lamp was enquired for that would be suitable for affording light to a group of miners working together, and at once a 15 C.P. lamp was supplied with a battery sufficient to keep it in action for 10 hours; this was enclosed in a box measuring 12 inches × 10 inches × 14 inches, mounted on two wheels, so that it could be easily moved from one part of the working to another.

Sir William Thomson, in a report upon the battery, dated October 27th, 1887, says, in reference to this: "For miners' lamps, and for many purposes in which the quantity of current used is so moderate that the mere cost of the zinc is not too serious, I believe it will be found more convenient and less expensive than a secondary battery charged by a dynamo. I found that the cost of lighting for materials consumed in the four-cell miners' lamp, which I have tested during a shift, or period, of eight hours, is one penny. After being run down it can be charged again in half a minute or a minute, unlike a secondary battery, which requires many hours to charge and a dynamo to effect the charge."

For the lighting of railway carriages a more powerful light is needed, and it must also in many cases burn for a greater number of hours, necessitating the employment of a larger and heavier battery, but for this purpose lightness of weight is not of paramount consideration. An arrangement has been designed by which existing railway lamps could be converted with ease into electric ones, the battery being enclosed in the cover of each lamp, and the weight not much increased. It is hoped that the simplicity of the necessary alterations, and the great saving of labour that would result from the substitution, may induce some of the railway companies to give this system of train lighting an extended trial. Head and tail lights for trains are also made, giving a powerful light for 12 hours.

A special lamp is made for the lobbies and boxes of theatres, possessing the inestimable advantage of freedom from all risk of fire. Even in those theatres where the electric light has already been installed, it is found impossible to altogether abolish gas, and jets are still in use in boxes, lobbies, passages, and other places. The introduction of a few of these battery lamps, which are self-contained and entirely independent of each other, would render it possible to have the gas supply entirely cut off, and the safety of the theatre from fire to that extent increased.

For house lighting, of course, it is essential to contrive casings for the battery of an ornamental character, and it is sometimes possible in the case of small lamps to enclose it in the body of the metal or porcelain lamp, but in other cases it is necessary to have a square receptacle underneath, forming a decorative stand for the lamp, which may be mounted in the hand of a bronze statuette, or in any other manner according to individual taste. The lighting of rooms by lamps round the cornice and of billiard tables by lamps under reflectors, the batteries being out of sight and at a distance, is also illustrated, a range of 12 cells, each about 1 foot square, being employed to run 30 lamps of 15 C.P. each.

The Schanschieff battery has been employed also in connection with motors for working sewing machines, punkahs, and other things. The following is the description of a battery supplied to M. Goubet, of Paris, for his submarine torpedo boat on its trial before the French naval authorities. A box containing eight cells, 18 inches by 10 inches, with a depth of 22 inches, and weighing when charged one ton, supplied electrical energy to a motor which developed two horse-power during a period of 10 hours.

Sir William Thomson in his report on the battery already referred to, testifies that its electromotive force is high and its internal resistance very low; that it is free from sudden variations, giving a steady and uniform light for hours; that it is free from polarisation and from the evolution of gas or fumes or smell; that it is thoroughly durable and may be kept for months or years charged and ready for use without any loss of zinc or solution; and without damage to any part of the cells or fittings; that it can be re-charged in half a minute; that it is less troublesome than any two fluid battery, and more convenient while less expensive than a secondary battery charged by a dynamo. Mr. W. H. Preece says in a report "Of all single fluid primary batteries for portable purposes which I have examined, there is none which equals in simplicity and efficiency that of Mr. Schanschieff's. The peculiar novelty of the cell, which distinguishes it from others,

is the character of the solution and the means by which the residue of the battery can be recuperated by means of heat.

"The cell consists of zinco-carbon and a solution of basic sulphate of mercury.

"Batteries containing bi-sulphate of mercury were used by Marie Davy and others, but Mr. Schanshieff has invented and patented a peculiar mode of dissolving the basic sulphate, which gives to the mercurial solution a strength and density that it never had before to my knowledge.

"It makes a cell which, for uniformity of action and simplicity of construction and maintenance, leaves little to be desired. It can be made of any dimensions to maintain any ordinary output of current.

"I have been testing and examining this battery for several months, and have given it the most careful consideration. A very accurate series of measurements were made with a lamp which produced one candle-power light for eight hours, at a cost of materials consumed of 1d.

"The residue of this battery is principally mercury, but zinc is also consumed, and is converted into sulphate of zinc.

"I do not consider the latter residue of any value, but the mercury which is thrown down by the decomposition of the mercuric sulphate can either be reconstructed into mercuric sulphate by Mr. Schanschieff's process, or it can be sold in the market or taken in exchange in part payment for additional solution.

"The duration of the light is simply a question of the lamp and the size of the battery. One ampère flowing for one hour requires about 1 oz. of mercuric solution per cell. Given a certain lamp to burn a certain number of hours, the size of the battery to maintain it alight is very simply calculated."

REVIEWS.

Electric Apparatus, Machines, and Arrangements: A Collection of Descriptions for the Use of Technologists, Engineers, Manufacturers, Telegraph Officials, Physicians, for Instruction and for Private Study. By W. E. FEIN. Stuttgart: Julius Hoffmann.

This work is one of an exceptional and most interesting character. In it the author describes the numerous electric appliances which he has constructed and manufactured at the establishment of C. and E. Fein at Stuttgart. It gives a striking proof at once of the ingenuity and of the incessant activity of the author during the last 20 years.

The devices here described and figured are classified as galvanic batteries and accumulators, magneto and dynamo-electric machines, measuring instruments and scientific apparatus, domestic telegraphy, fire signals and indicators, burglar alarms, an electric alarm for mortuaries by which attention is at once drawn to any signs of life given by a supposed corpse, &c. Further, we find electric clocks, appliances for indicating and registering the level of water in reservoirs, milldams, &c., telephonic instruments, appliances for electric light, electric motors, apparatus for decomposing water, dynamos for electrolytic purposes, and medical electrotechnics. Finally come a number of devices which have not been included under any of the above heads, such as arrangements for lighting gas-burners and an apparatus for testing lightning conductors. In short, Herr Fein's useful activity has extended itself to every kind of the practical applications of electricity.

As an instance of remarkable ingenuity we may mention the instrument for indicating an escape of gas in houses, &c., or a collection of "fire-damp" in any part of a coal-mine. Here the author takes advantage of the altered specific gravity of the body of air in the locality, which closes a circuit and sets alarms in action at any required distance. In rooms the apparatus is placed near the ceiling, where coal-gas first collects. In mines it is fixed in parts where explosive gas has been observed to issue.

An "electro-magnetic separator" has for its purpose the removal of fragments of iron out of corn, bones, and other materials which have to be ground. Such fragments, derived from machinery, from the shoes and harness of horses, &c., occur far more frequently than might be expected, and often occasion serious damage. The apparatus which Herr Fein proposes could not be intelligibly described without a reproduction of the accompanying illustrations.

The apparatus for indicating the level of water is applicable, with slight modification, for meteorological registrations.

The author's contrivance for testing lightning conductors shows the resistance of the rod and its connections in a very simple manner, and with a degree of accuracy fully sufficient for the purpose. The purpose is effected by means of a Wheatstone bridge in connection with a galvanometer of suitable sensibility.

It is, however, impracticable for us to notice, within the limits of space available, more of Herr Fein's ingenious inventions. The work will prove exceedingly valuable to the practical electrician. The illustrations —297 in number—are admirably executed.

Transactions of the American Institute of Electrical Engineers. Vol. IV. New York: Published by the Institute.

This volume embraces the whole of the papers read at the half-dozen meetings held between June 8th last year and June 28th of the present one, with the discussions thereupon. The subjects receiving attention at those meetings were of wide significance, as will be seen when we state that some of them were: "Incandescent Lighting from Central Stations," "Electric Street Cars," "Practical Requirements of Small Motors," "Distribution of Electricity by Secondary Generators," "Storage Batteries in Practice," and "Electric Lighting of Passenger Trains." The most interesting and important of those papers have already appeared in our pages, sufficient indication of our estimate of their worth. We are pleased to note that a full report of each meeting is to be hereafter published in a separate number during the month in which the meeting is held.

NOTES.

Incandescent Lamps for Street Lighting.—In Newton, Mass., there is in operation by the local Electric Light Company, the new incandescent street system of the Thomson-Houston Electric Company, which may be briefly described as a group of 40 lamps of 25 candle power each at 25 volts, *in series* between the main conductors of the alternating current dynamo which furnishes current at the same time to a number of converters in multiple. There are several novel and ingenious features in this system which is giving such excellent satisfaction as to call forth commendatory letters from the local authorities.

Central Station Lighting in America.—In little more than five years from the installation of the first Edison central station in America, no less than 103 companies have sprung into existence to spread the system. New York and Chicago each have a central station running 15,000 lamps, and at Detroit, New Orleans, St. Paul, Philadelphia, Brooklyn, the stations all have 10,000 lamps in circuit. New York has a second station with 10,000 lamps, and a third and fourth with 8,000 each. The number of lamps at other stations vary from 300 to 8,000 and the total of the 103 stations amount to 313,000 lamps.

Central Station Difficulties in Berlin.—The failure of the installation at the Vienna Opera is not the only example of a breakdown in a central electric station, says *Industries*' correspondent at Berlin. That in the Beuthstrasse of this town has from its beginning been subjected to a series of mishaps, and quite recently the cylinder of one of the two Armington-Sims engines burst, and the whole of the work had to be done by the remaining engine. As this would inevitably have led to a complete breakdown, two Willan engines have been installed, so as to keep the station going. This station belongs to a private company, which is also lighting the Ausstellungspark. In this case power is supplied by seven Willan engines. In this station during last summer the armature of a 25-light Brush machine flew to pieces, and this summer the shaft of a "Victoria" dynamo was twisted off. As it can hardly be assumed that the workmanship or material of the machinery were defective, these mishaps are ascribed to bad management.

Central Station at Elberfeld.—A few days ago the central electric light station at Elberfeld was started. This is the first station in Germany, says *Industries*, which employs the three wire system, and also the first which has not been erected by a private company, but by the municipality. At present there are installed three steam engines with boilers each of 120 H.P., manufactured by Herr G. Kuhn, of Berg, near Stuttgart, and six 35-unit dynamos, wound for 110 volts. The current is measured by the new Aron meters, arranged for the three-wire system, the pendulum of the clock being provided with two magnets and two solenoids, one in each circuit. The junction with the houses is made in special street service boxes, where the fusible plugs are also placed, this being a departure from the usual practice in Berlin, under which the fusible plugs are placed in the houses of consumers. For purposes of distribution the town has been divided into certain districts, each served by its own network of triple mains, and fed by special feeders. To reduce variation of pressure, provision has also been made by which the equi-potential mains can be joined amongst each other.

The Breakdown at the Vienna Opera. — The cause of the failure of the electric lighting at the Vienna Opera is commonly ascribed to the boilers, and to them only; "but," says *Industries*' correspondent, "I have reason to know that also in the street mains and in the wiring within the Opera House itself, defects have commenced to show themselves. Up to the present the storage battery in the Opera is that part of the plant which has given least trouble, In electrical circles here the news of the failure, although not entirely unexpected, has been received with considerable regret, and this is the more remarkable, since our dynamo makers and electrical engineers have been almost entirely set aside by the action of the Court and of the Imperial Continental Gas Company, who would not condescend to employ the home industry to a greater extent than they could possibly help. At the bottom of the failure seems to be the interference of Court officials and others with the plans of the engineer, and electricians here are sincerely sorry that Mr. Crompton's name should be mixed up with this failure, since he only supplied the dynamos and the regulating appliances for the lights in the Opera, both of which are satisfactory, whilst for the failure in the rest of the plant he is in no wise responsible. The installation at the Burg Theatre will, in consequence of the present unsatisfactory state of affairs, be considerably delayed.

After 12 days' interruption, the Vienna Opera was reopened on Sunday. The arbiters declare that the bursting of the boilers, which threw the whole of the electric lighting installation out of working order, was attributable to the fact that the water hitherto supplied was impure.

The Electric Light in Parliament.—To carry out the proposal for lighting the whole of the buildings, comprising the Houses of Lords and Commons, by electricity, the introduction of 5,000 lights will be necessary, while at the present time there are not more than 500 lights in use. The present system of electric illumination has given universal satisfaction, and the impression exits that the House of Commons will readily sanction its extension in the manner suggested.

The Electric Light in Clerkenwell. — Mr. J. W. King has lighted his new gilding and plating works at Clerkenwell by the electric light. The plant consists of an Atkinson gas engine, driving an Edison Z type dynamo, together with a battery of accumulators. At present only 22 incandescent lamps and one arc lamp are used, but these will be added to as required. The whole of the installation has been erected by Mr. King and his workmen under the superintendence of his son, who is a pupil to a firm of electrical engineers. The current employed for depositing at the works is furnished by a converted Crompton-Burgin dynamo and by an Elwell-Parker dynamo in connection with sets of accumulators.

Electric Lighting v. Gas.—The President of the American Gas Association, Mr. Greenough, at a recent meeting said, "Before gas can be abandoned some other light must appear which is equally reliable, and either better or cheaper. How are these requisites fulfilled by electricity? Better? yes; in some places. Cheaper? no, hardly anywhere. Equally reliable? not yet." If this be true in America, says the *Gas World*, where gas averages about seven shillings per 1,000 cubic feet, with how much greater force must it appeal to the providers of electric light in Great Britain, where gas is sold, on the average, at less than half the amount quoted.

Weston-super-Mare and the Electric Light.—Last Friday a deputation of Town Commissioners and influential residents went from Weston-super-Mare to Taunton to observe the electric lighting of that town with a view to introduce the same method of illumination in Weston. Mr. Massingham, managing director of the Taunton Electric Lighting Company, conducted the party through the works and over the town, and afterwards a high tea was partaken of in the company of a number of Taunton aldermen and councillors, who were unanimous in praising the electric light, asserting that though they paid a little more than would have been paid for gas, they had a much better article for their money. There is very little doubt that Weston, one of the prettiest watering places on the west coast, will soon add another to its already numerous attractions.

Theatre Lighting in Paris.—The *Moniteur de l'Industrie du Gaz* says there are at present three theatres lit by electricity in Paris, the Opéra, the Variétés, and the Palais-Royal. At the Variétés, in the first ten evenings, the proceedings were interrupted three times by the light going out: at the Opéra the machines make a noise and a perceptible throb, and there have already been a man killed and several incipient fires, but there has not been any extinction. The Opéra has not sent away its gas meter.

Lighting the Palais Royal by Electricity. — The shopkeepers in the Palais Royal in Paris have entered into a contract with the Edison Electric Light Company for the lighting of their shops and the arcades in the building by electricity.

Telephones and the Poor.—Mr. John James Jones, of the London Samaritan Society, writing to the *Times*, says that the difficulty with regard to the provision of shelter for the houseless poor who have hitherto been compelled to sleep in the open air, is not so much the lack of accommodation as the want of knowledge in the crowded districts as to where the accommodation is to be found, and he suggests the extension of telephonic communication between the various casual wards and workhouses of the metropolis, so that when one is full and obliged to send applicants away, it may know where to send them.

Electric Light on a Farm.—A Swedish farmer has hit upon the ingenious idea of lighting his farm by the electric light, having purchased a dynamo and connected it with a waterfall close by. At present the machine is only used for lighting, but the man intends also to employ it for working threshing machines, &c. The light has been found cheaper than paraffin oil.

The South of England Telephone Company.—In issuing the notice convening the half-yearly meeting of the company, the directors give the following particulars of the progress made during the past half-year :—April 30th, 1887, exchange subscribers, 1,130 ; private line renters, 348. October 31st, 1887, exchange subscribers, 1,316 ; private line renters, 373. The following additions to the trunk line system have been made :—Brighton-Lewis, Brighton-Shoreham, Margate-Ramsgate. The dividend on the 6 per cent. preference shares up to the 31st ult. has been paid.

A Telephone Boom.—Among the impending sensations of the market, says the *Financial News*, is said to be a telephone boom. Some long-eared people got wind of it a few days ago, and have been quietly buying Uniteds from $11\frac{1}{4}$ upwards. Yesterday (Thursday, November 17th), they were still buying vigorously, though the dealers were making them pay $12\frac{1}{4}$, and were not anxious to sell even at that. A grand combination is being arranged, and though the details are kept very secret, enough of them is known to make sure that it will be a good thing for United.

Van Rysselberghe System. — The total length of lines on which the telegraph and the Van Rysselberghe telephone system are used simultaneously is shown in the following table :—

	Kilometres.
Austria	288·0
Bavaria	600·0
Belgium	7,206·0
Denmark	10·0
France	4,044·906
Germany	1,032·0
Holland and Dutch East Indies ...	386·7
Spain	140·0
Switzerland	536·0
Wurtemburg	880·0
	15,123·606

The lines proposed or in course of construction are as follows :—

	Kilometres.
Austria	670·0
Bavaria	400·0
Germany	200·0
Italy	640·0
Portugal	624·0
Spain	872·0
Roumania	514·0
Russia	1,300·0
Turkey	700·0
	5,920·0

National Telephone Company Conversazione.—The seventh annual conversazione of the employes of the National Telephone Company and their friends took place at Glasgow on Friday last, when 120 couples met and spent the evening in dancing. At an interval the party gathered round the platform, and Col. R. Raynsford Jackson, chairman of the company, reported the progress which had been made during the year. Afterwards Sir William Thomson addressed the assembly upon the wonderful growth of the telephone in Glasgow since the time when he (Sir William) brought the first Graham-Bell telephones before the British Association in 1876.

The Telephone in Denmark.—A new telephone line is now being laid between Copenhagen and the City of Roskilde, and by other extensions communication has been established between the extreme north of Jutland and the central part. A telephone is also being laid between the towns of Kiel and Flensborg, in Holstein. The time allowed in Jutland for each conversation is five minutes.

Bradford Post Office. — The headquarters of the postal telegraph department at Bradford was transferred from its old premises in Tyrrel Street to the new post office in Forster Square during the night of Saturday last, the 19th inst. At ten o'clock the whole of the circuits working to offices open during the night were switched into the new building, the apparatus and batteries belonging to minor circuits being transferred as the night proceeded. At eight o'clock on Sunday morning the whole system of public and private wires was in working order at Forster Square. It is stated by the *Bradford Observer* that the new instrument room has been wired, as an experiment, with the new lead covered wire, the special properties of which were explained to the Society of Telegraph Engineers by Mr. Eddison. The whole of the connecting wires pass into the office in underground pipes, so that the architectural beauty of the building is not marred by unsightly overhouse wires and standards. It is stated that the old office in Tyrrel Street, which is being kept open for the reception of messages from the public, will be ultimately connected with Forster Square by means of a pneumatic tube. The contract for laying down the pipe and providing a 6-horse gas engine for the supply of the necessary power has been let. The removal of the telegraphs was carried out by the local engineering staff, under the superintendence of Mr. Moir the inspector.

Students' Meeting.—A meeting of the students of the Society of Telegraph-Engineers and Electricians was held on Thursday, the 17th inst., Prof. Perry, M.E., D.Sc., F.R.S., in the chair. Mr. J. Rance, jun., opened a discussion upon Profs. Ayrton and Perry's paper, "Modes of measuring the coefficients of self and mutual induction," explaining various forms and use of the secohmmeter, including the latest form, the reversing secohmmeter. The advantages claimed for this form of instrument are :—(1) The sensibility is doubled. (2) May be used when the magnetic circuit is closed. (3) The battery circuit is broken for a very short time, the E.M.F. therefore does not change much. Reference was also made to Mr. Sumpner's paper "The measurement of self-induction, mutual induction, and capacity." Owing to the kindness of Profs. Ayrton and Perry many instruments and diagrams were exhibited. The discussion was maintained by Messrs. E. W. Smith, Cooper, Bate, Dykes, Lamb, and Prof. Perry. After thanking the chairman for presiding, the meeting terminated. The next students' meeting will be held on Thursday, December 1st.

Glasgow International Exhibition, 1888.—The Executive Committee for the electric lighting of this exhibition appears to have lost no time in deciding the question of tenders. Tenders were required to be sent in not later than the 15th inst., and the same week the following were accepted :—For the entire lighting of the exhibition and grounds by means of some 500 arc lights, the tender of the Anglo-American Brush Electric Light Corporation was accepted. In the incandescent lighting of the refreshment department by means of about 800 lamps, the tender of Messrs. King, Brown and Co., of Edinburgh, has been accepted. For the lighting of the picture galleries, the tender of Mr. Richard Millar, for arc lighting on the Thomson-Houston system, has been accepted. It may be remembered that for this section the alternate systems were mentioned in the specification.

Electric Locomotion in Spain.—An effort is being made in Madrid to procure the substitution of electric motors for horses in the operation of the street cars.

Electric Clubs in America.—The electric club idea has evidently "caught on" in the States. Cincinnati is now about to follow in the footsteps of Boston, Chicago, and New York, and form a club of its own, where electrical men may forget trade rivalry and professional jealousies in the pleasures of social intercourse.

Efficiency of the Direct v. the Alternating System of Distribution.—Before the Massachusetts Gas Commissioners recently, Prof. W. D. Marks, of Philadelphia, made the somewhat amazing statement that the maximum efficiency of the alternating dynamo is about 70 per cent., and that the efficiency of the converter ordinarily used in connection with it is 80 per cent.; from which he deduced that the total maximum efficiency of the alternating system is 56 per cent., as against 85 for the direct system of the Edison type. He also asserted that the economy of the direct system, within the distance of two-thirds of a mile, is from 60 to 100 per cent. greater than that of the alternating system. At the same hearing Mr. W. F. Jenks, of the Edison Company, stated that at Brockton, Mass., seven and-a-half 16-candle lamps per horse-power were obtained. The company furnishing the alternating system guarantees 10 16-candle lamps per horse-power. The problem that the *New York Electrician and Electrical Engineer* says it would like to have solved is this:—How is it that a system having a maximum efficiency of only 56 per cent. furnishes 160 candles per horse-power, while another system having an efficiency of 85 per cent. can furnish only 120? It would be interesting to electric light engineers to know the authority for the figures of the eminent professor.

Underground Wires in Detroit.—The Brush Company, of Detroit, has decided to put its wires underground within the half-mile circuit.

Electric Locomotion.—*Industries* devoted its leading article last week to the subject of "Mechanical Traction on Street Railways," referring mainly to the proceedings of the convention of the American Street Railway Association. Summing up the lessons taught by the convention, our contemporary finds "that whilst this body officially declares that steam, hot air, hot water, petroleum, and other purely mechanical engines have failed to compete successfully against horse traction, and that cable tramways can only in exceptional cases so compete, yet they seem to endorse the private opinions expressed by the promoters of various systems of electrical traction; and the tacit acquiescence of so influential a body as this association bodes well for a speedy development of electric power on tram lines in America. It will be well for our own electrical engineers to take note of the direction in which affairs are moving in America, so that they may not be left behind in the progress of this industry."

The "Wild West" Show at Manchester.—A very large structure is now being erected on the Manchester Race-course for Buffalo Bill and his troupe, who are paying a lengthened visit to Lancashire. The lighting of the show will be principally by arc lights, and the Anglo-American Brush Electric Light Corporation have received the necessary instructions to proceed with a "Brush" arc installation.

Protographing Bullets in Motion by the Electric Light.—An Austrian physicist, Herr H. Mach, of Prague, has made some interesting experiments on photographing rifle bullets in motion by means of the electric light. In doing this he illumines the bullet by letting it break an electric current formed, but the velocity of the bullet must exceed that of sound in order that the conditions of the air before and behind the projectile can be shown. After many experiments Herr Mach succeeded in photographing projectiles fired by Mr. Wernal and Mr. Jurde's guns, having respectively an initial velocity of 438 and 530 metres per second. The photographs thus obtained showed an air formation in front of the bullet having the form of an hyperbole, whilst behind it almost a vacuum was formed, in which, when the initial velecity was very great, there were some curious spiral motions. On the whole there appeared from these photographs to be a great similarity between the motion of a body through the water and that of a projectile through the air.

Central Station Lighting in Austria.—The central electric light station at Salzburg is now in regular work, *Industries'* Vienna correspondent reports. There are at present only 26 arc and 250 glow lamps in use, but the distributing plant has been laid down for a very much larger supply of electricity, not only for lighting, but also for motive power. A project is on foot for building an electric railway to the top of the Mönchoberg. This is to be a rack railway operated from the central station. The whole of the distributing plant has been laid underground, and the cables are specially insulated and protected, so that they could be placed at a short distance under the surface of the streets without any troughs or other protection. There are over three miles of main cable. The work has been carried out by Messrs. Siemens and Halske. Another central station is projected for Carlsbad, in Bohemia. The only example of electric lighting at present in that town is a separate small installation for the theatre, and as the town authorities have a very stringent contract with the Nürnberg Gas Company, the new central station will not be erected without some difficulties, legal, financial, and others. The general feeling in the town is, however, at present very much in favour of a central station for the supply of electricity, not only for lighting, but also for working a small railway in the neighbourhood, and the magistrates have appointed a committee to report on the matter.

Australasian Electric Lighting.—Alluding to the recent meeting of the Australasian Electric Light, Power and Storage Company, reported in our issue for October 21st, the *Financial News* says the company "is one of those concerns which, after the manner of New Zealand financiers, made haste to discount prosperity. The chairman, at the fifth ordinary meeting of the company, appealed, as it were, from Philip drunk to Philip sober. But, really, allowing for the intoxication of ante-dated success, Philip's behaviour was inexcusable. He makes a good confession, but it is tardy. Of the £120,000 which was the company's original available capital, not less than £85,000 vanished in the first year of the undertaking. No less a sum than £45,000 was lavishly paid for patents: with other thousands Philip played ducks and drakes—a noble pastime for lavish youth, but usually fatal to the comfort of riper years. Amongst other wild and useless outlays we note an item of £5,000 for an advertising trip of Sir Julius Vogel. That was five years ago, before Sir Julius had cultivated the art of cutting down stipends and travelling expenses by practising on the minor officials of the New Zealand Civil Service. It is to be hoped that when next the company call Sir Julius Vogel to their aid the directors will be careful to count the cost beforehand. In the meanwhile the chairman tempers fond regret with rosy hope. Some day, somehow, and somewhere the shareholders are to look for better results."

Electricity and Railway Working.—The following are among the conclusions, formulated from the proceedings of the second International Railway Congress recently held at Milan, and appended to the questions arranged for its consideration by the Permanent International Commission:—"13. *Lighting and Warming.*—What results are obtained by new methods of lighting trains (petroleum, electricity)? Enriched gas is preferable to naphthaline; and, on account of the technical difficulties attending the electrical lighting of trains, this part of the question is left over to next congress." "19. *Lighting of Stations.*—What results have been obtained by gas and electricity?—Electric lighting is preferable to that by gas; but further information and experience are required."

Slaughtering by Electricity.—Recently some experiments have been made in St. Petersburg with the idea of slaughtering cattle by electricity, the results of which have been highly satisfactory—death being in all cases instantaneous.

Glasgow College of Science and Arts.—The following results were announced by Prof. Jamieson at the distribution of prizes which took place the other day. We do not know of any technical institution in the kingdom which has made more rapid or better progress than this one, which now forms part of the Glasgow and West of Scotland Technical College. Comparative table of results of Science and Art and City and Guilds examinations from 1880 to 1887 :—

Year.	Certificates.		Honours.		Medals.		Whitworth Scholars.
	1st.	2nd.	1st.	2nd.	Silver.	Bronze.	
*1880	43	57	...	...	...	...	...
1881	79	100	...	3	...	...	...
1882	138	235	2	6	1	1	...
1883	195	233	3	4	2	5	...
1884	275	372	4	11	...	4	4
1885	383	406	4	15	...	6	2
1886	506	651	19	18	1	13	6
1887	449	688	26	30	2	8	5
	2068	2742	58	87	6	37	17

* The year before the College of Science and Arts was constituted.

Society of Arts.—The Society of Arts has presented its silver medal to Mr. A. Reckenzaun for his paper on "Electric Locomotion."

Is Electricity Dutiable?—The *Washington Critic* says that the Collector of Customs at Eastport, Me., recently submitted an unusual question to the Treasury Department. He wanted to know whether duty was to be assessed upon electricity which came over the wires from Canada to supply electric light for Calais, Me. Mr. Secretary Fairchild has replied that electricity is an invisible, subtle agent or power, without any substance as a mercantile commodity, and is not provided for in the tariff or liable to duty.

The Medical Use of Electricity.—Mr. William Lynd has, as we have already announced, taken quarters at Bournemouth, and in that famous health resort is doing successful curative work with the aid of the electric current. He has just removed paralysis from the leg of a lad by applying continuous and alternating currents in combination. It is satisfactory to learn that the medical profession in Bournemouth are warm friends of the electrical method of treatment, and send Mr. Lynd many of his patients.

The Largest Electric Street Car.—The *Electrical World* describes what it terms the largest electric street car in the world in a recent issue. It is one built by Mr. William Wharton, jun., of Philadelphia, and fitted with Reckenzaun motors and gearing. There are two motors, and each weighs about 500 lbs. ; the pair, when working to their fullest capacity, being capable of giving 30 horse-power collectively. The car has been tested on the experimental line, and it was ascertained that the current, when mounting the grade of 5½ per cent. (264 feet to the mile), was only 80 ampères, on the level 25, and this current was supplied by 74 storage batteries ; but there are actually 120 cells on board, stowed away under the seat on long boards, which run on rollers to facilitate the speedy removal and replacement of the whole battery. The seats are of the usual height and width, but they are 22 feet long, accommodating about 34 people, so that with the available standing room and platforms a hundred passengers can be crowded into the car. The frames of the four-wheeled trucks are made of wrought iron ; they have a very light appearance, yet they are of ample strength to support the maximum load with safety. The wheels are only 26 inches in diameter, which, when revolving at 103 revolutions per minute gives a speed of eight miles an hour when the motors run at 824 revolutions, the armature speed being reduced 8 to 1 by means of Reckenzaun's worm gearing.

"What's in a Name?"—Mr. A. E. Kennelly, of London, has written an article for the New York journal which bears the same name as ourselves, and he has given it this title : "On the Analogy between the Composition of Derivations in a Telegraph Circuit into a Resultant Fault, and the Composition of Gravitation on the Particles of a Rigid Body into a Centre of Gravity."

The Secret Powder Again.—Yet another mystery ! The solution in the Armstrong primary battery is kept up to its strength by the daily deposit in one of the cisterns of a small quantity of "electronite" (a new depolariser) which the company will supply as required in packets labelled for each day of the week or month. We also learn that by means of "Armstrong's Itinerant Master Battery and Apparatus" it is expected that a large profit will be made. Mr. F. H. Varley reports that the time occupied in producing light does not exceed three quarters of a minute. There are some tall rumours floating about in connection with this battery, which seem to indicate that it will eclipse the "Eclipse" and out d'Humy d'Humy ; but more of this anon.

Conversazione of the Telegraph Engineers.—The President of the Society of Telegraph-Engineers and Electricians and Lady Bright have issued invitations for a *conversazione* to be held at the Galleries of the Institute of Painters in Oil Colours, Piccadilly, on Thursday evening, the 15th December.

Small Arc Lamps.—On the invitation of the Chairman of the Maxim-Weston Electric Company (Mr. Hugh Watt, M.P.), we saw a few days since at the works of the company a small arc lamp, the object of which is to obtain a greater subdivision of light than has hitherto been possible by means of arc lighting. The lamp in question requires from 2½ to 3 ampères and 40 to 45 volts, giving about 150 C.P. It will thus be seen that at least six lamps of this power can be obtained from one electrical horse-power. The lamp is regulated by a clockwork movement controlled by a brake, and Mr. Watt claims that by his improvement he secures a steadier light than can be obtained by any known arc lamp, and also that the difficulty hitherto experienced in the lighting of large open or enclosed spaces, viz. : the question of distribution at a low rate per lamp will be overcome. He estimates that a large complete installation of the "Watt" dynamo and lamp will not cost more than one-halfpenny per lamp per hour, while the present arc lamp costs something like five times that amount. Should the lamp in question answer the claims put forth regarding it, there is no doubt that it will tend in a very large degree to overcome the difficulty which has prevented our towns and cities being lighted by electricity on a large scale as in America, namely, the question of cost.

Callender's System of Insulation. — Underwriters wire has already been universally condemned in the United States for inside work. We now hear that it has been discarded in an important overhead contract, and that the Thomson-Houston Company has just arranged with the Callender Insulating Company for 250 miles of insulated line wire to be used overhead at the Electric Light Station which is now being erected in New York. The amount of the contract is about $40,000. The wires are No. 4 and No. 6 gauge insulated with bitumen, and braided.

Accidents in Mines.—The discussion on Sir Frederick Abel's paper on "Accidents in Mines" was resumed at the Institution of Civil Engineers, Westminster, on Tuesday evening. A collection of mining appliances, in model and otherwise, has been formed, and was on view during the evening, This collection includes miners' lamps of almost every type, from the original Davey to the latest electric lamps, of which there were several varieties. The collection will remain on view for another week or ten days, and the discussion on Sir Frederick Abel's paper will be resumed and concluded on Tuesday evening next.

Telegraph Tenders.—The Cheshire Lines Committee advertises for tenders for the supply, during the year 1888, of telegraph materials, instruments, wire, &c. Specifications with forms of tender may be obtained upon application to Mr. W. H. Legge, storekeeper, Cheshire Lines, Warrington; tenders to be in the hands of Mr. E. Ross, secretary, London Road Station, Manchester, by December 3rd.

The Water Primary Battery.—We understand that at Mr. D'Humy's office, where the celebrated water primary battery is shown, there is, or was, on the top floor a gas engine and a dynamo machine. It not being of any importance we will not specify the makers of these, although we have this information; but we should like much to hear from Mr. D'Humy or Mr. Gooch for what purpose this machine and engine are used.

The Electro-Harmonic Society.—The programme of the "Ladies' night" may be found on page 5 of our supplement. The hon. secretary having had a number of enquiries as to whether evening dress is *de rigeur*, requests us to state that while the rule would not be rigidly enforced, it is usual so to appear.

Correspondence.—We have received letters from Mr. Hugh A. Fergusson and Mr. Charles Lever, which arrived too late for insertion.

The Compound Winding Case.—The important "compound winding" action on the Brush patent, brought by the Anglo-American Brush Electric Light Corporation, Limited, against Messrs. Crompton & Co., has been settled. Messrs. Crompton have accepted the usual license, and have agreed to judgment in favour of the Corporation. The cross action brought by Messrs. Crompton & Co. on the Crompton-Kapp patent has been withdrawn, the Brush Corporation taking an assignment of that patent. This settlement will doubtless cause some surprise in electrical circles, but it is perhaps best that the case has so ended. The royalty demanded by the Corporation is not excessive, and now that doubts respecting the strength of the Brush combination can no longer exist in the minds of contractors or manufacturers, they will doubtless accept the inevitable with a good grace, and work can be put in hand with a full knowledge of the circumstances under which the construction of such machines is allowable.

Cheaper than Gas.—The managing-director of Messrs. Geo. Richards and Company, Limited, of Broadheath, near Manchester, states, as the result of four years' experience, that the total cost of working 30 Lever arc lights (including 10 per cent. for interest and depreciation) has not exceeded £100 per annum. He feels sure it would cost more to light the works with gas, over which the electric light possesses many advantages.

To Electrical Contractors.—The Executive Committee of the Grand Competition of Sciences and Industry, Brussels Exhibition, 1888, invites the principal electricians of all countries to compete for the lighting of the buildings and grounds of the exhibition. The conditions of participation in this competition will be sent to the various firms, together with a form of application. The motive power is supplied gratuitously. A second invitation will be issued for the installation and working of electrical tramways. The project comprises traction by means of self-moving cars, and by means of locomotives constructed to draw two cars, each containing twelve persons. Applications must be forwarded to the manager of the section of lighting and electricity, 22, Rue des Palais, Bruxelles. This section is placed under the direction of Monsieur Mourlon, the well known electrician, and Monsieur Bandsept as chief engineer.

A Challenge.—Mr. Webster's challenge to a primary battery contest will, we fear, bring forth no acceptances, especially as the arbitrator must be a man of reputation. With regard to our correspondent's second paragraph, the statement to which he takes exception was culled from a copy of Mr. Nursey's paper which had been supplied to us.

Primary v. Secondary Batteries.—We are surprised to see that Sir William Thomson compares the time occupied in charging primary and secondary batteries in the same manner as did Mr. Walsh of "Eclipse" fame, whose arguments we dealt with on p. 454 of our issue for November 4th. Surely Sir William must have forgotten that secondary cells are not charged singly, and it is to be regretted that he should be credited with a statement which will be readily seized upon by the unscrupulous for the purpose of misleading the public.

The Schanschieff Battery.—We believe Mr. Schanschieff's primary battery will be largely used for many purposes. The thing is genuine, the inventor does not claim impossibilities, and on the strength of the reports of Sir William Thomson and Mr. W. H. Preece success is assured if the invention is only properly handled.

Dynamo Field Magnets.—Signor G. Pedretti, of Milan, offers for sale the British patents of an improved field magnet, which is thus described: "This improved field magnet is built up in the following manner: a cylinder of soft iron being taken as a nucleus, the usual coil of insulated copper wire is wound around it; outside this copper wire is placed another iron cylinder, or rather two cylinders, with an annular space between. These two cylinders are connected solidly at one end, but are open at the other. Around this double cylinder another coil of the insulated copper is placed; outside this second layer of wire another double cylinder is placed, similar to the first. This process of building up can, of course, be continued if desired, but for ordinary purposes the magnet is now complete and ready for use." This appears to be nothing more nor less than the Camacho system disinterred from the oblivion in which it has rested for some years. The following so-called test is quoted as a proof of the advantages to be derived from its employment, but to those who know what return may be expected from a given expenditure of energy it carries its own condemnation: "Acting in combination with certain improved conductors, and revolving at a velocity of 1,000 per minute the result was 20 lamps of 16 candle-power as against 10 similar lamps when the same armature was placed in a dynamo of the usual type. *The power employed was* 1 *H.P.*

Royal Scottish Society of Arts.—Recently the report of the committee appointed to award prizes, &c., for communications read or reported on during the past session was submitted. The committee reported that the special thanks of the society were due, amongst others, to George R. Primrose, London, for his additional paper on his "electric meteorological scale reader," accompanying their thanks with a complimentary Hepburn medal. The committee awarded to Johnston Stephen, electrician, Ravelston Cottage, Blackhall, Midlothian, for his description of an "automatic replacement electrical indicator," a Keith prize, value ten sovereigns; and to F. M. Moore, nautical optician, Belfast, for his "improvements in the marine compass and its adjustments," a Keith prize, value ten sovereigns. The committee also reported that the best thanks of the society were due to Johnston Stephen for his paper on "Tele-Barometers."

The Royal Society.—It is said that the Council of the Royal Society objects to Prof. Stokes as president, on the grounds that he is a politician.

NEW COMPANIES REGISTERED.

Marine Life Saving Appliances Company, Limited.—Capital, £60,000 in £1 shares. Objects: To purchase the patent and other rights of Frederick Hargrave relating to Hargrave's Patent Safety Night and Distress Signals and Rocket Discharger, Hargrave's Patent Electrical Sounding Apparatus, and Hargrave's Patent Improved Cork Life Buoy. Signatories (with one share each): J. F. Foskett and Charles Jayne, Southend, Essex; W. Balch, 32, Elderfield Road, Clapton; F. H. Letts, 31, Chiswick Road; A. S. Forbes, 85, Ladbroke Grove Road, W.; F. Hargrave (electrician), 35, Queen Victoria Street. The subscribers appoint the first directors. Qualification for directors (other than the first) 250 shares. Remuneration, £1,000 per annum. Registered 17th inst. by J. Foskett, 377, Strand.

Automatic Trading Company, Limited.—Capital, £100,000 in £1 shares. Objects: To acquire the invention of Alfred Wm. Armstrong for the adaptation of electricity to automatic and other apparatus, and the manufacture of automatic delivery boxes. Signatories (with one share each): J. Phillips, Daneville Road, S.E.; Henry Wade, 25, Maxted Road, Peckham; H. Sprague, 17, Charles Street, Northampton Square, W.C.; R. J. Howard, 36, Gordon Dwellings, Camberwell; R. Howard, 26, Claude Road, Peckham; C Wren, Luton. The signatories are to appoint the first directors. Remuneration, £100 per annum each, with £50 additional for the chairman. Registered 22nd inst. by Goldring, Mitchell and Phillips, 20, Abchurch Lane, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Medical Electric Belt, Truss, and Health Appliance Company, Limited.—An agreement of 12th inst. (filed 19th inst.) provides for the allotment of 50 fully-paid shares in the company to Mr. Frederick Wood, of 58, New Bond Street, in pursuance of the purchase agreement dated 26th March.

Northern Electrical Engineering Company, Limited.—An agreement of 16th August (filed 8th inst.) relates to the purchase by the company of the business of F. H. Perry & Co., Limited, of 36, Victoria Street, scientific apparatus manufacturers and electrical engineers. As part of the consideration this company will pay £950 cash, £1,000 in debentures, and 750 fully-paid shares of £1 each.

Consolidated Telephone Construction and Maintenance Company, Limited.—The Chancery Division of the High Court of Justice, by an order dated 29th ult. (filed 16th inst.) directs the reduction of the capital upon terms of the special resolution passed at an extraordinary meeting held on the 2nd June, and confirmed on the 23rd June. The capital is therefore reduced from £243,787 10s. to £232.545, divided into 224,850 shares of 14s. each, and 75,150 shares of £1 each.

Elieson Electric Company, Limited.—The statutory return of this company, made up to the 28th ult., was filed on the 21st inst. The nominal capital is £600,000 in £5 shares. 35,985 shares are taken, and the full amount is considered as paid up thereon. Registered office, 31, Liverpool Street.

J. G. Statter and Company, Limited.—The statutory return of this company, made up to the 12th August, was filed on the 18th August. The nominal capital is £20,000 in £10 shares. 1,090 shares have been taken up, 640 being considered fully paid. Upon 450 shares £3 per share has been called, the calls paid amounting to £1,320, leaving £30 unpaid.

Clamond Incandescent Gas Light Company, Limited.—The registered office of this company is at 76, Coleman Street.

CITY NOTES.

South of England Telephone Company, Limited.—The half-yearly meeting of this company was held yesterday (Thursday) at Winchester House, but the business was of a merely formal character. The Chairman reported fairly satisfactory progress in every part of the district covered by the company, and two or three shareholders offered suggestions for the improvement and extension of the system in various towns. We shall give a report of the proceedings in our next issue.

United Telephone Company, Limited.—The directors give notice that the transfer books of the company will be closed from the 19th inst. to the 2nd prox., both days inclusive, preparatory to the payment of an interim dividend of 5s., less income tax, per fully paid share, part paid shares receiving in proportion, being at the rate of 10 per cent. per annum.

The Eastern and South African Telegraph Company, Limited.—This company announces the numbers of 257 five per cent. mortgage debentures of £100 each which have been drawn for payment at par on January 1st, 1888.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 18th were £3,385, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th November are £2,699, as compared with £2,129 in the corresponding period of 1886. The July receipts, estimated at £4,762, realised £4,851.

NEW PATENTS—1887.

15703. "Galvanic battery for medical purposes." J. COURT. Dated November 16.

15717. "Electrical date and time stamp." C. A. RANDALL. Dated November 16.

15721. "Electrical movement or mechanism for automatic sale of goods." A. W. ARMSTRONG. Dated November 16.

15726. "Conductors used in incandescent electric lamps." N. K. CHERRILL. Dated November 16.

15730. "Galvanic batteries." J. VAUGHAN-SHERRIN. Dated November 16. (*Complete.*)

15735. "Electrical indicating or signalling apparatus." W. R. LAKE. (Communicated by C. Grivalas.) Dated November 16.

15754. "Electrolytes of secondary voltaic batteries." W. J. S. BARBER-STARKEY. Dated November 17.

15759. "Mechanical appliance for communicating with railway trains while in motion." A. E. PORTE. Dated November 17.

15760. "Electrolytic treatment of sewage and sea water for the purpose of producing certain products therefrom." W. WEBSTER. Dated November 17.

15778. "Obtaining adhesion to the rails and braking the wheels of electric cars, locomotives, and other vehicles." A. J. JARMAN. Dated November 17.

15779. "Electrical motors." A. J. JARMAN. Dated November 17.

15801. "Incandescence electric lamps." W. H. BECK. (Communicated by A. M. Michel.) Dated November 17.

15843. "Sounder screen for telegraph purposes." G. BEECH, G. WELCH. Dated November 18.

15858. "Dynamo-electric machines." W. MAIN. Dated November 18. (*Complete.*)

15877. "Telegraphic apparatus suitable for indicating position of a ship's rudder." J. B. WILLIS. Dated November 18.

15881. "Alloy for electrotyping therewith." C. A. MEYGRET, P. MARINO. Dated November 18.

15883. "Electric safety lamp apparatus." W. G. ADAMS. Dated November 18.

15891. "Instruments for measuring electric currents." W. H. DOUGLAS. Dated November 19.

15922. "Spring jack for telephonic and other electrical purposes in which it is desired to change or switch a current from one conductor to another." A. COLEMAN and OTHERS. Dated November 19.

15939. "Electrolytic treatment of sewage, &c." W. WEBSTER. Dated November 19.

15943. "Galvanic batteries." O. C. D. ROSS. Dated November 19.

15965. "Erecting or renewing telegraph, telephone, &c., wires." A. S. DUNN. Dated November 21.

15985. "Automatically directing and restoring the course of an electric current." E. BERGHOLT. Dated November 21.

16032. "Dynamo-electric machines." W. MAIN. Dated November 22. (*Complete.*)

16058. "Telephonic apparatus." G. F. REDBURN. (Communicated by L. de Cornbettes.) Dated November 22.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1886.

11003. "Improvements in electrical railways." C. D. ABEL. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated August 28. 11d. Claims:—1. Constructing electric railways with double rails having a channel between them within which are contacts or conductors branching from a main conductor situated either within or below or at the side of the said channel, the said contacts being made to convey the currents from and to the conductor or conductors to and from contact slides moved along in the said channel by the vehicles by means of connections passing through the slot of the rail, substantially as described with reference to the accompanying drawings. 2. Constructing the branch conductors referred to in the preceding claim of U form with lateral contact surfaces enclosed between an insulating body and a conducting spring covering, substantially as described with reference to the drawings. 3. Constructing the branch conductors referred to in the first claim of U form entirely enclosed in an insulating body, and having contact surface at their upper ends, substantially as described with reference to the drawings. 4. Arranging the branch conductors of the positive and negative main conductors to enter the same channel between the two rails so as there to make contact with two separate contact slides, substantially as described with reference to the drawings. 5. The described construction of articulated contact slide carried by a frame suspended from the axle boxes of the vehicle, the ends of which frame can adjust themselves to the curvature of the line, while the connection of the slide with the intermediate joints thereof are capable of shifting laterally, substantially as described with reference to the drawings.

12451. "Improved means or apparatus for transmitting rotary motion to or from electric machines." J. H. HOLMES. Dated October 1. 8d. Claims:—1. For transmitting rotary motion to or from the armature of an electric machine, the application and use of a pair of frictional wheels or pulleys whereof one is mounted on a shaft connected by a flexible coupling to the armature of the electric machine and capable of being moved to bring the said frictional wheel or pulley into engagement with the other or corresponding wheel or pulley, substantially as described and for the purposes specified. 2. The combination with a motor and an electric machine erected on the same bed, or otherwise relatively fixed, of a pair of frictional wheels or pulleys of which one is mounted on a shaft connected to the armature of the electric machine by a flexible coupling, and capable of being moved to bring the said frictional wheel or pulley into engagement with the corresponding wheel or pulley, substantially as described, for the purposes specified. 3. The combination of motor, driving apparatus, and electric machine, arranged and operating substantially as described with reference to the drawings.

12818. "Improvements in secondary batteries." W. W. BEAUMONT. Dated October 8. 8d. Claims:—1. Constructing electrodes for secondary batteries by placing in position at definite distances in a mould lozenges or cakes substantially of the forms shown and described and made from "lithanode" or oxide or oxides, or hydrated peroxide or salts of lead or like active material, and then forcing or pouring molten lead into the mould under pressure, thus enclosing the active material in a metallic lead holder or setting, substantially as set forth. 2. Constructing electrodes for secondary batteries by placing in position in a mould lead wire or lead fabric coated with a firmly adherent coating of "lithanode," or of lead oxides or salts, and then forcing or pouring molten lead into the mould under pressure, and thus enclosing the coated wire or fabric in a lead holder or setting, substantially as set forth. 3. The improved electrodes for secondary batteries shown and described.

13126. "Improvements in or connected with reflectors for portable electric incandescent lamps." J. G. LORRAIN and S. WATERS. Dated October 14. 8d. The inventors employ a reflector whose body consists of glass, preferably of such form that it will surround the lamp bulb in all directions except that occupied by the lens or pane of glass or other transparent material through which the light is required to pass. This body of glass may be either coated or impregnated with reflecting matter, or have matter of a more or less reflecting nature embedded therein, as specified. The claims are 12 in number.

13186. "Improvements in combining steam engines with dynamo-electric and other machines driven directly by them." P. W. WILLANS. Dated October 15. 8d. Claims:—1. A steam engine with its crank chamber divided horizontally in the plane of the axis of the crank shaft into two parts, of which the lower contains the lower portions of the bearings of the crank shaft and has an extension or extensions supporting the stationary parts of a dynamo-electric or other machine, whilst the crank shaft carries or is directly coupled with the armature or rotating part, all substantially as described, and so that when the upper part of the crank chamber and the upper part of the driven machine are both removed, the crank shaft and the attached rotative portion of the machine are accessible and can be lifted out together. 2. The improvements substantially as described in combining steam engines with dynamo-electric and other machines driven directly by them.

13641. "Improvements in the means for indicating and for regulating the electrical potential in systems of electrical distribution." B. J. B. MILLS. (Communicated from abroad by J. W. Howell, of America.) Dated October 25. 8d. Claims:—1. Indicating or regulating the pressure in two or more electrical circuits—in one, the standard circuit directly by the pressure therein, and in the others by a movement produced upon instruments by the resultant of electrical forces acting cumulatively or differentially on such instruments, such forces being derived from said standard circuit and from said other circuits, substantially as described. 2. The combination in a system of electrical distribution, of two or more feeding circuits, a standard circuit which may be one of the feeding circuits or a special local circuit, an absolute indicator in said standard circuit, bridge wires connecting the conductors of said standard circuit with like conductors of each of the feeding circuits (or of each of the remaining feeding circuits if the standard circuit is one of these) and differentially wound indicating or regulating instruments, included one in each pair of said bridge wires, whereby indication or regulation of the pressure of the circuits is produced by movement of said instruments due to an electrical comparison between the pressure of the standard circuit and that of each of the other circuits.

14075. "Improvements in electric lamps." R. E. PHILLIPS. (Communicated from abroad by W. S. Hill, of America.) Dated November 2. 8d. The objects of the invention are to improve and simplify the construction of clutch mechanism lamps, and more especially to render their operation more steady; to produce a practical balance of the mechanism when the lamp is operating; to dispense with dash-pots, clockwork, gearing, or other similar devices generally used; to provide a simple and effective "cut-out"; to provide a setting device whereby the lamp may be more surely, speedily and easily lighted; to provide a simple and effective means for holding the carbons in position, and generally to produce an extremely sensitive mechanism for operating the lamp that will produce a steady and uniform light. The claims are 9 in number.

CORRESPONDENCE.

The Lever Dynamo.

Having just noticed Mr. C. Lever's note respecting the intersection of polar armatures (page 475, November 4th, 1887) in their pole pieces, in which he claims to be the inventor, I wish to say that I have for nearly three years made both Pacinotti and Siemens armatures (to call Mr. Lever's attention, let him see my specification, 2,122, 1885) to run in laminated pole pieces, but instead of boring out the grooves I have a V channel planed out to receive the stamped pole piece with a washer to part them. I tried the boring out of the pole pieces, but it is no joke to turn 90 grooves for the armature discs to run through, and hence my idea to have them in stampings. I had a great objection to this, as my armatures had only $\frac{1}{20}$th of an inch clearance, and when a little end shake came on, the armature would no doubt come to destruction. I find I get better results by using the laminated pole pieces and armature without any intersection. There is no pulling the machine to pieces to get out the armature, and less heating.

H. Jones.

Startling Proposal: To Mr. d'Humy.

In a letter from a friend in New York the following passage occurs:—"I see that Mr. d'Humy is about to light up your part of London with his water battery. Why does he not use the Thames, with Westminster and Blackfriars Bridges as electrodes?"

I am ashamed to confess my ignorance, but really I can't say why he doe:'nt. Perhaps Mr. d'Humy will enlighten me.

Sydney Evershed.

November 22nd, 1887.

Edison's Phonograph.

I would feel obliged to any of your readers who could let me know if Edison's phonograph is to be purchased anywhere, and where?

J. A. Berly.

November 21st, 1887.

[According to Mr. Edison's own statements, his apparatus is not yet in the market.—EDS. ELEC. REV.]

Speed of Working Cables.

I shall be glad if some of your readers who have practical experience of the speed of working through Atlantic or other long cables will inform me what is the *maximum* number of words obtained by actual experiment through any existing cables, and also what is the *ordinary working speed* for the same cables, or will refer me to sources where the required information may be found.

My object is to obtain two or three reliable instances on which to base calculations for determining the maximum and ordinary working speed of cables generally.

Enquirer.

Submarine Research.

I am much interested in what your correspondent "X. X. X." says with regard to two or three statements which occurred in my paper on "Deep Sea Sounding in connection with Submarine Telegraphy." He will perhaps like to know my reasons for making them.

With regard to the effect of deposits on the iron armour of cables he does not misquote, but the words "effect if any" referred to purely deep sea deposits. When treating of shore deposits I particularly mentioned the existence of deposits, dangerous through their chemical action, in certain localities, and indeed referred to an article in the ELECTRICAL REVIEW of the 6th August, 1886, on the subject. I think when "X. X. X." comes to read what I said, he will find that there is no difference of opinion between us on this point.

My reason for advocating the use of sinkers which only detach the weight on the wire being hauled taut from on board, and not immediately on striking bottom, is that by this means a very much better sample of bottom is obtained, as the tube is forced well down into hard ground, and the "plug" of this, at the bottom of the tube, may often secure the soft ooze above, which without it would escape. As to overrunning the wire, this very seldom occurs, and I think rather indicates carelessness in those working the machine. When it does occur the wire is almost sure to kink and break under any circumstances. The little strain I like to be able to put on the wire before the weight is released from the sinker, gives time for the ship to be got back into position should the lead of the wire be not quite vertical, the slack wire meantime being wound in by hand, and the depth noted at the moment the weight is released, which can be seen by the dynamometer. The sinker which I have recently designed, and which I described, although keeping the weight on till the slack wire is picked up, does not require any actual strain to release the weight, and may be preferred.

I certainly did understand Mr. Buchanan to say that fingering the wire causes rust, but I now think with your correspondent that I misunderstood him.

With regard to attaching valuable instruments to wire I see no objection to this, provided the wire has been proved to be in good condition, and is not overweighted. I think the use of buoy rope and the heavy machinery necessary for its recovery should be avoided.

Edward Stallibrass.

Train Lighting in Germany.

I see by your notes column this week that gas lighting is coming into favour on the German railways. This is scarcely what one would expect after the severe lesson taught by the accident which occurred on the 19th of June last between Berlin and Potsdam, resulting in the burning of some of the carriages, and causing the death of several passengers. An account of this appeared in the *Times* newspaper of the 21st of June, and would doubtless have excited considerable comment but for the fact of its publication occurring just in the midst of the Jubilee celebrations.

It is needless to point out to you that such disastrous results would have been quite impossible had this train been lighted by electricity, and it is my opinion that in the interest of both the railway companies and the public attention should be called to the risk by the storage of gas in trains.

In the interest of electricity perhaps you may think this matter worthy of further comment.

Cipher.

November 21st, 1887.

Pumping by Electricity in Coal Mines.

I have been very much interested in reading a brief description in your last week's issue of the electrical pumping plant at Messrs. Lock's collieries, Normanton, which appears to be doing good work. We have working at these collieries what I believe to be the largest pumping plant at present driven by electricity. A pump delivering 114 gallons per minute through a head of 300 feet = 10·36 H.P. is placed more than a mile underground, and is doing excellent work. This is the third pump so working here—the first having been started more than four years ago. I shall read a paper before the South Wales Institute of Engineers at Cardiff on Thursday next, giving full particulars as to the cost and efficiency of this plant.

Frank Brain.

Trafalgar Collieries, Forest of Dean,
November 21st, 1887.

Primary Batteries.

May I be allowed to trespass upon your valuable space in reference to those bugbears primary batteries as one of the most interested in the Holmes-Burke type.

I may mention that the statement in your leading article intimating that the proprietors of this battery state that "the light, of whatever candle-power it may have been, was maintained at the average cost of $\frac{1}{8}$th of a penny per light per hour" is incorrect, and I should much like to know from whom you obtained this information, as the figures given by Mr. Nursey in his paper were very different.

There are several installations of modified type of above (the improvements of your humble servant), and the latest construction under my patent will, I trust, be of service both for lighting, telegraphic, and mining purposes. It is not my intention to raise a company, or ask anyone for a penny. The chief cost of working these batteries is, not the labour, but consumption of material.

I challenge any primary battery inventor or maker to the following trial, but the plates used must not be prepared electrolytically, as I look upon such as accumulators or secondary batteries, and the cells must be of a similar size and number to mine. The battery shall be prepared and allowed to run a given number of Swan-Edison lamps of a given E.M.F. and candle-power. The runs shall extend over 14 days or more, the time occupied in labour shall be carefully noted, also consumption of materials. If my battery fails as against others, I will consent to pay £25 to any deserving charity, or I will present it to the Chemical Society or Telegraphic Engineers, to purchase the successful battery for future experiments in their lecture rooms. I of course debar colourable imitations of my battery from competition.

The arbitrator must be an electrician and chemist of reputation, and not pecuniarily interested in any battery system.

I also intend to submit a certain number of cells for trial as to their suitability for telegraphic or mining purposes; but as this would mean leaving them when charged with acids, &c., for at least six months, it would naturally have to be in connection with some telegraph company.

William Webster, jun., *F.C.S., A.S.T.E. &c.*

November 22nd, 1887.